이학박사학위논문

Taxonomic Study on the Selected Nereidid Species (Annelida: Polychaeta) from Northeast Asian Waters Based on Morphology and Molecular Data

동북아시아 해역에 서식하는 주요 참갯지렁이과 다모류의 분류학적 연구

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박 태 서

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ABSTRACT

Taxonomic Study on the Selected Nereidid Species (Annelida: Polychaeta) from Northeast Asian Waters Based on Morphological and Molecular Data

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A taxonomic study was carried out on the nereidid species from Northeast Asian waters. A total of 105 nominal species were compiled based on literatures. Of these, 27 taxonomically ambiguous nominal species were selected and reexamined through molecular and morphological analyses based on type and non-type specimens.

An approach of 'reverse taxonomy' was applied to examine taxonomic validity of selected nereidids based on COI sequences. Totally 234 sequences from 32 nereidid species including comparative species were analyzed. These analyses revealed the likely presence of undescribed or misidentified species among previously reported nereidids (*Perinereis wilsoni* Glasby and Hsieh, 2006; *P. cultrifera* (Grube, 1840); *Pseudonereis variegata*

(Grube, 1857); *Hediste japonica* (Izuka, 1908); *Nereis denhamensis* Augener, 1913; *N. vexillosa* Grube, 1851; *N. pelagica* Linnaeus, 1758; *N. multignatha* Imajima and Hartman, 1964; *Platynereis bicanaliculata* (Baird, 1863); *Cheilonereis cyclurus* (Harrington, 1897)) from Northeast Asian waters. The result of taxonomic revision of 27 selected nominal species based on molecular and morphological data are as follows: 1. Present taxonomic status of ten nominal species (*Hediste atoka* Sato and Nakashima, 2003; *H. diadroma* Sato and Nakashima, 2003; *Nectoneanthes oxypoda* (Marenzeller, 1879); *N. uchiwa* Sato, 2013; *N. heterocirrata* Treadwell, 1931; *N. tigrina* Zachs, 1933; *Perinereis aibuhitensis* (Geube, 1878); *P. linea* (Treadwell, 1936); *P. mictodonta* (Marenzeller, 1879); *P. shikueii* Glasby and Hsieh, 2006) are confirmed by COI sequence comparison and morphological observation; 2. More than four cyptic species were determined from four species (*Hediste japonica*; *Nereis multignatha*; *Perinereis wilsoni*; *Platynereis bicanaliculata*) and one is newly described (*Nereis* sp. nov. 3 from *N. multignatha*); 3. Seven species reported from Northeast Asia (*Perinereis floridana* (Ehlers, 1868); *P. cultrifera*; *Nereis denhamensis*; *N. pelagica*; *N. vexillosa*; *N. neoneanthes* Hartman, 1948; *Pseudonereis variegata*) have been misidentified. *Perinereis floridana* and *P. cultrifera* turned out to be *P. euiini* Park and Kim, 2007; *Nereis denhamensis* and *N. vexillosa* turned out to be *N*. sp. nov. 1 and *N*. sp. 4, respectively. *Pseudonereis variegata* turned out to be a new species. *Nereis neoneanthes* is newly identified as *N. multignatha*. *Nereis pelagica* turned out to be an undescribed species, however, further study of morphology is needed to describe it; 4. *Cheilonereis cyclurus* differs from its type specimen. *Cheilonereis shishidoi* is reinstated which was a junior synonym of *C. cyclurus* based on examination of topotype materials and molecular comparison; 5. Two nominal species *Nereis* (*Neanthes*) *orientalis* Treadwell, 1936 and *Perinereis vancaurica tetradentata* Imajima, 1972 are newly synonymized to *P. linea* based on their type specimens; 6. *Alitta brandti* Malmgren, 1865 and *Pseudonereis anomala* Gravier, 1901 turned out to be misidentified and, further taxonomic study is needed to confirm their taxonomic status; 7. Three species (*Hediste didroma*, *Nereis tigrina*, and

Perinereis shikueii) are newly reported from Korean waters. Furthemore, two unknown species were collected from Korean waters during field survey for this study. They are described as new species: *Nereis* sp. nov 2 and *Composetia* sp. nov.

At present, 105 nominal nereidid species have been reported from Northeast Asian waters. As a result of this study, 80 species might be valid although some of these are uncertain. Among these, 51 species are endemic to this region.

Key words: Taxonomy, Molecular taxonomy, New nereidid species, Nereidid polychaetes, Northeast Asian waters.

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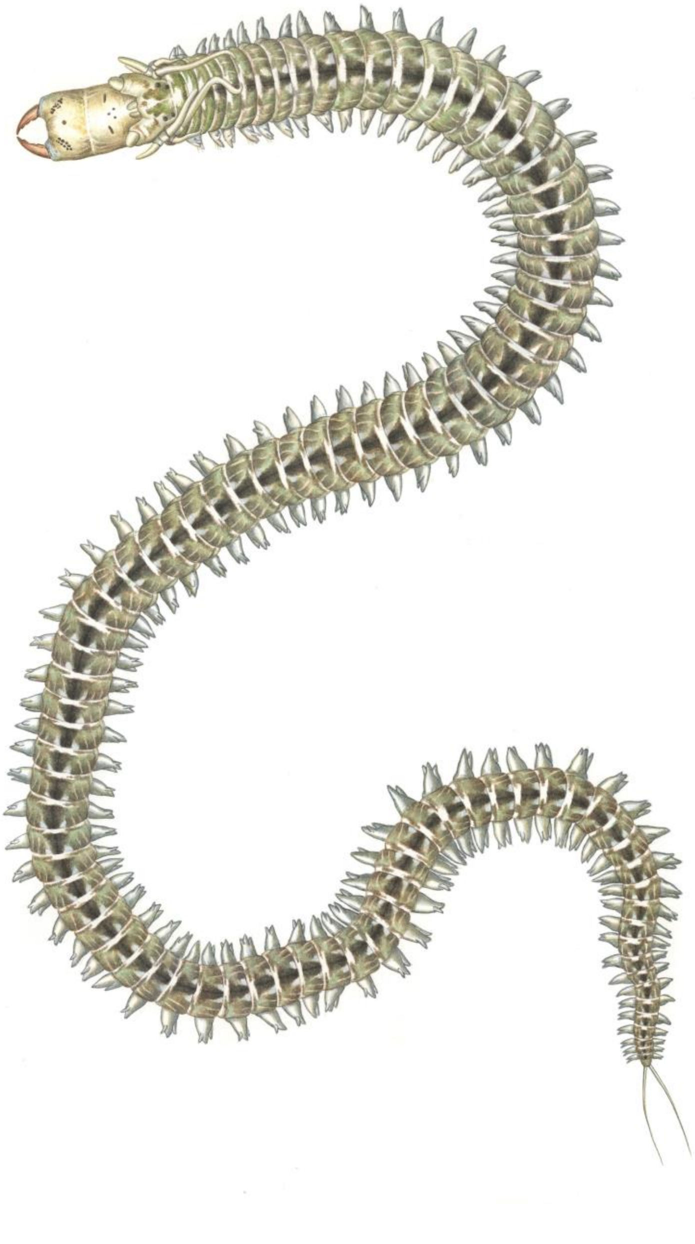

‘*Perinereis euiini* Park and Kim, 2017’

Background

Background

The family Nereididae (Annelida: Polychaeta) is one of the oldest groups among polychaetes that have been taxonomically recorded. They were even mentioned in pre-Linnaean writing (Fauchald and Rouse, 1997). Nereidids are among the most widespread and diverse polychaete families. They have 43 genera with over 535 species (Beesley et al., 2000; Bakken, 2004). They are common in shallow marine habitats. They also occur in a wide range of environments, including deep sea, estuaries, fresh water streams, and even temporary rainwater puddles (Dales, 1963; Beesley et al., 2000). Nereidids are also regarded as dominant groups in macrobenthic communities. They play a critical role in the ecosystem. They are important prey for other animals such as fishes and wading birds in marine and esturine food chains. They are sometimes used for human consumption (Gambi et al., 1994; Olive, 1994; Iwamatsu et al., 2007; Kan et al., 2016). Some species (such as *Perinereis* Kinberg, 1866 species) are harvested commercially for use as fishing bait for anglers and mariculture (Gambi et al., 1994; Scaps, 2003).

Many polychaetologists have made notable contributions to taxonomic study of nereidids from Northeast Asia. The earliest record for nereidids in Northeast Asia was probably made by Grube (1866) during the Novara expedition of 1857–1859. He described a new species of *Tylorhynchus chinensis* (= *T. heterochaetus* (Quatrefages, 1866) fide Hartman, 1959) from Shanghai, China. Thereafter, Chamberlin (1924), Monro (1928, 1934), Fauvel (1933), Treadwell (1936), Khlebovich and Wu (1962), and some other researchers have reported nereidids from China. A total of 81 species belonging to 19 genera have been recorded (Wu et al., 1985). In Taiwan, Wu (1967) has reported 19 nereidid species, including 16 new records. Glasby and Hsieh (2006) have added three new species and three new records. Kamita and Sato (1941) have reported *Ceratocephale osawai* Izuka, 1903 (= *Tylorrhynchus heterochaetus* (Quatrefages, 1866) fide Hartman, 1959) from Incheon, Korea. This record is the first taxonomic record of nereidids from Korea. Korean nereidids were mainly recorded by Paik (1972, 1973, 1975, 1976, 1977, 1982, 1989). A few other researchers have also studied nereidids from Korea (Rho and Lee, 1982; Lee et al., 1992; Park and Kim, 2007; Hong et al., 2012). According to Lee et al. (2015), 37 species belonging to 17 genera of nereidids are currently recorded from Korea. The first record of nereidids from Japanese coast was made by Marenzeller (1879). He reported the following five *Nereis* Linnaeus, 1758 species (including two new species): *N. mictodonta* sp. nov. (= *Perinereis mictodonta* fide Glasby and Hsieh, 2006), *N.* (*Alitta*) *oxypoda* sp. nov. (= *Nectoneanthes oxypoda* fide Sato, 2013), *N. pelagica* Linnaeus, 1758, *N. diversicolor* Müller, 1776 (= ?*Hediste japonica*), and *N. dumerilii* Audouin and Milne Edwards, 1834 (= *Platynereis dumerilii* fide Fauvel, 1914). After his work, several research groups (Izuka, 1908, 1912; Imajima, 1972; Sato and Nakashima, 2003; Sato and Kubo, 2009; Sato, 2013) have contributed to the description of nereidids from Japanese waters. Currently, 54 species belonging to 20 genera of nereidids have been reported from Japanese waters (Sato, 2017). Russia Far Eastern polychaetes were not studied until the 1920's. Annenkova (1937, 1938) and Zachs (1929, 1933) have made important contributions to preliminary survey of polychaetes including nereidid species. A total of 17 species belonging to five genera of nereidids were reported (Uschakov, 1965).

The geographic coverage for this study is Northeast Asian waters (i.e., East China Sea, the Yellow Sea, the East Sea, southern part of the Sea of Okhotsk, and Japanese coast of the Pacific Ocean). Tropical regions such as South China Sea were excluded from this study (Fig. 1). This area is mostly characterized as temperate water mainly influenced by Kuroshio warm current from the south with Kuril and Liman cold currents from the north (Barkley, 1970; Qiu, 2001). In the aspect of marine biogeography, this area belongs to Indo-West Pacific region. This area can be subdivided into three biogeographic regions: 'Sino-Japanese', 'Oriental', and 'Kuril' (Toonen et al., 2016) (Fig. 1, 2).

Oceans are all connected in the earth. They have been present for a very long time.

Some marine animals have achieved circumglobal distributions. However, most marine species have limited distributions due to marine biogeographic barriers (Gaither et al., 2015; Toonen et al., 2016). According to this, high endemism of marine fauna is expected in Northeast Asian waters.

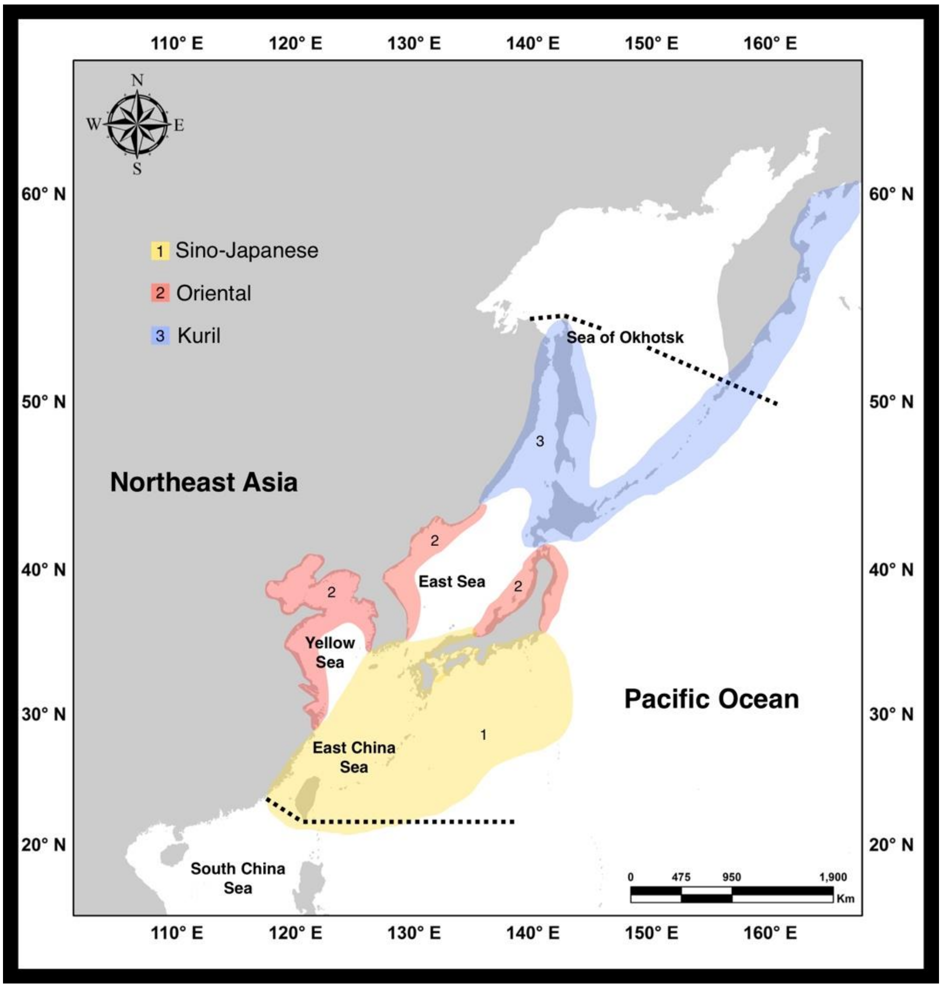

Fig. 1. Geographic coverage of present study. Northeast Asian waters: the East China Sea, the Yellow Sea, the East Sea, southern part of the Sea of Okhotsk, and Japanese coast of the Pacific Ocean. Marine biogeographical provinces are indicated by different colors.

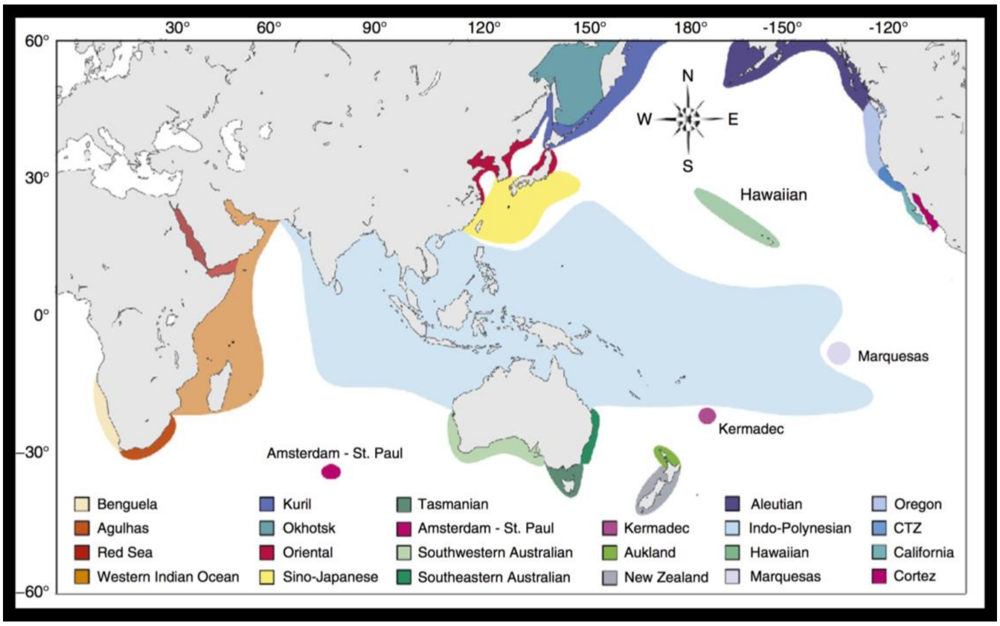

Fig. 2. Map of the Indo-West Pacific Province. Each province is indicated by a different color. Taken from Toonen et al. (2016).

As discussed by Salazar-Vallejo et al. (2014), widely distributed species are usually historically over-represented among regional faunas. For example, Imajima and Hartman (1964) have indicated that, of 467 species, 158 (33.8%) are “known from areas outside the Pacific Ocean”.

At present, 105 nominal names of nereidids have been reported in Northeast Asian waters. Of these, 53 nominal names were originally reported from different areas not belonging to this biogeographic region (Table 1). They could represent undescribed species, or belong to regional described species that have been treated as junior synonyms.

In the present study, the list of 105 nominal names of nereidid from Northeast Asia are compiled based on the literatures (Table 1). Of these, 27 taxonomically ambiguous species were selected and reexamined through molecular and morphological analyses based on type and non-type specimens (Table 2). Also, two species were newly discovered from Korean waters and described in this study.

Table 1. A list of 105 nominal names of nereidid species or subspecies from Northeast Asian waters, and their currently valid name. The results from this study are excluded.

Subfamily genus	Nominal names (Type locality)	Currently valid names	References
Namanereidinae			
Lycastis	1. *L. longicirris* Takahashi, 1933; (Taiwan)	*Namalycastis longicirris* (Takahashi, 1933)	Hartman (1959)
Lycastopsis	2. *L. augeneri* Okuda, 1937; Imajima, 1972; Paik, 1977; Wu et al., 1985; (Japan)	*Namanereis littoralis* (Grube, 1871) species group	Glasby (1999)
Namalycastis	3. *N. hawaiiensis* (Johnson, 1903); Sato, 2017; (Hawaii)	valid	Sato (2017)
	4. *N. indica* (Southern, 1921); Wu, 1967; (Mozambique)	valid	Wu (1967)
Gymnonereidinae			
Ceratocephale	5. *C. borealis* Wesenberg-Lund, 1950; Imajima, 2009; (Japan)	valid	Imajima (2009)
	6. *C. osawai* Izuka, 1903; (Japan)	*Tylorrhynchus heterochaetus* (Quatrefages, 1866)	Hartman (1959), Imajima (1972)
	7. *C. sibogae* (Horst, 1918) *sensu* Khlebovich & Wu, 1962; (Indonesia)	*Tambalagamia fauveli* Pillai, 1961	Wu et al. (1985)
Tambalagamia	8. *T. fauveli* Pillai, 1961; Imajima 1972; Wu et al., 1985; Paik, 1982; (Sri Lanka)	valid	Sato (2017)
Nereidinae			
Ceratonereis	9. *C. burmensis* Monro, 1937; Wu, 1967; Uchida, 1990; (Myanmar)	*Neanthes glandicincta* (Southern, 1921)	Lee & Glasby (2015)
	10. *C. erythraeensis* Fauvel, 1918; Imajima, 1972; Wu et al., 1985; Paik, 1977; (Percian Gulf)	*Simplisetia erythraeensis* (Fauvel, 1918)	Hartmann-Schröder (1985)
	11. *C. hircinicola* (Eisig, 1870); Imajima, 1972; Wu et al., 1985; Paik, 1982; (Mediterranean Sea)	*Composetia hircinicola* (Eisig, 1870)	Hartman (1938)
	12. *C. japonica* Imajima, 1972; (Japan)	valid	Imajima (1972), Sato (2017)
	13. *C. mirabilis* Kingberg, 1866; Imajima, 1972; (Brazil)	valid	Imajima (1972), Sato (2017)
	14. *C. moorei* Imajima, 1972; (Japan)	*Composetia moorei* (Imajima, 1972)	Hartmann-Schröder (1985)
	15. *C. pachychaeta* Fauvel, 1918; Imajima, 1972; Wu et al., 1985; (Madagascar)	*Neanthes pachychaeta* (Fauvel, 1918)	Glasby et al. (2011)
Cheilonereis	16. *C. cyclurus* (Harrington) *sensu* Okuda, 1950; Imajima, 1972; Wu et al., 1985; Paik, 1977; Khlebovich, 1996; Sato, 2017; (Puget Sound)	valid	Sato (2017)

Table 1. Continued.

Subfamily genus	Nominal names (Type locality)	Currently valid names	References
Hediste	*17. H. atoka* Sato & Nakashima, 2003; (Japan)	valid	Sato & Nakashima (2003)
	18. H. diadroma Sato & Nakashima, 2003; (Japan)	valid	Sato & Nakashima (2003)
Leonnates	*19. L. nipponicus* Imajima, 1972; (Japan)	valid	Imajima (1972), Salazar-Vallejo et al. (2014), Sato (2017)
	20. L. persicus Wesenberg-Lund, 1949; (Persian Gulf)	valid	Sato & Kubo (2009), Sato (2017)
Neanthes	*21. N. caudata* (Delle Chiaje, 1822) *sensu* Imajima, 1972; Paik, 1977; (?)	*Neanthes acuminata* (Ehlers, 1868)	Reish et al. (2014).
	22. N. diversicolor sensu Marenzeller, 1879; Imajima & Hartman, 1964; (Norway)	? *H. japonica* (Izuka, 1908)	from synonymy
	23. N. donghaiensis Wu, Sun & Yang, 1981; (China)	valid	Wu et al. (1985), Salazar-Vallejo et al. (2014)
	24. N. flava Wu, Sun & Yang, 1981; (China)	valid	Wu et al. (1985)
	25. N. glandicincta (Southern, 1921); Wu, 1967; (Indo)	valid	Wu (1967)
	26. N. succinea (Leuckart, 1847); Imajima, 1972; Paik, 1977; (Germany)	valid	Sato (2013, 2017)
Nectoneanthes	*27. N. latipoda* Paik, 1973; (Korea)	*N. oxypoda* (Marenzeller, 1879)	Sato (2013, 2017)
	28. N. multignatha Wu, Sun & Yang, 1981; (China)	*N. oxypoda* (Marenzeller, 1879)	Sato (2013, 2017)
	29. N. uchiwa Sato, 2013; (Japan)	valid	Sato (2013, 2017)
Nereis	*30. N.* (*Alitta*) *oxypoda* Marenzeller, 1879; (Japan)	*Nectoneanthes oxypoda* (Marenzeller, 1879)	Sato (2013, 2017)
	31. N. (*Leptonereis*) *distorta* Treadwell, 1936; (China)	*Tylorrhynchus heterochaetus* (Quatrefages, 1866)	Pettibone (1971a)
	32. N. (*Neanthes*) *amoyensis* Treadwell, 1936; (China)	*N. amoyensis* (Treadwell, 1936)	Hartman (1956)
	33. N. (*Neanthes*) *linea* Treadwell, 1936; (China)	*Perinereis linea* (Treadwell, 1936)	Wu (1967), Arias et al. (2013)
	34. N. (*Neanthes*) *orientalis* Treadwell, 1936; (China)	*Perinereis aibuhitensis* (Grube, 1878)	Hartman (1938)
	35. N. (*Neanthes*) *virens* Sars, 1835 *sensu* Annenkova, 1938; Uschakov, 1965; (Norway)	*Alitta brandti* Malmgren, 1865	Khlebovich (1996)

Table 1. Continued.

Subfamily genus	Nominal names (Type locality)	Currently valid names	References
Nereis	36. *N. abbyssa* Imajima, 2009; (Japan)	valid	Imajima (2009)
	37. *N. cultrifera sensu* Izuka, 1912; (Naples, Italy)	*Perinereis cultrifera* (Grube, 1840)	Imajima (1972); Sato (2017)
	38. *N. cylindrata* Ehlers, 1868; (Rijeka Bay)	*N. zonata* Malmgren, 1867	Fauvel (1913)
	39. *N. denhamensis* Augener, 1913 *sensu* Imajima, 1972; Wu et al., 1985; Paik, 1977; Sato, 2017; (Australia)	valid	Imajima (1972); Sato (2017)
	40. *N. dyamushi* Izuka, 1912; (Japan)	*Alitta brandti* Malmgren, 1865	Khlebovich (1996)
	41. *N. ezoensis* Izuka, 1912; (Japan)	*N. vexillosa* Grube, 1851	Annenkova (1937)
	42. *N. falcaria multignatha* Wu, Sun & Yang, 1981; (China)	valid	Wu et al., (1985)
	43. *N. grubei* (Kinberg, 1866); (Chile)	valid	Wu et al., (1985)
	44. *N. heterocirrata* Treadwell, 1931; (Japan)	valid	Treadwell (1931), Wu (1967), Imajima (1972), Wu et al. (1985), Paik (1977)
	45. *N. huanghaiensis* Wu, Sun & Yang, 1981; (China)	valid	Wu et al., (1985)
	46. *N. ijimai* Izuka, 1912; (Japan)	*Nectoneanthes oxypoda* (Marenzeller, 1879)	Sato (2013, 2016)
	47. *N. izukai* Okuda, 1939; (Japan)	valid	Okuda (1939), Imajima (1972)
	48. *N. japonica* Izuka, 1908; (Japan)	*Hediste japonica* (Izuka, 1908)	Sato (2003, 2017)
	49. *N. lithothamnica* Annenkova, 1938; (Russian Far East)	valid	Annenkova (1938), Uschakov (1965)
	50. *N. longior* Khlebovitch & Wu, 1962; (China)	valid	Khlebovitch & Wu (1962)
	51. *N. mictodonta* Marenzeller, 1879; (Japan)	*Perinereis mictodonta* (Marenzeller, 1879)	Glasby & Hsieh (2006), Park & Kim (2007), Sato (2017)
	52. *N. multignatha* Imajima and Hartman, 1964; (Japan)	valid	Sato (2017)
	53. *N. neoneanthes sensu* Imajima and Hayashi 1969; Imajima, 1972; (Alaska)	valid	Imajima (1972); Sato (2017)
	54. *N. nichollsi sensu* Imajima, 1972; (Australia)	*Pseudonereis anomala* Gravier, 1901	Bakken (2007)
	55. *N. pelagica sensu* Imajima, 1972; (Weastern Europe)	valid	Imajima (1972); Sato (2017)
	56. *N. pelagica multignatha* Imajima & Hartman, 1964 (Japan)	*N. multignatha*	Imajima (1972); Sato (2017)

Table 1. Continued.

Subfamily genus	Nominal names (Type locality)	Currently valid names	References
Nereis	*57. N. pusilla* Moore, 1903; (Japan)	*Composetia moorei* (Imajima, 1972)	Imajima (1972), Hartmann-Schröder (1985)
	58. N. sakhalinensis Okuda, 1935; (Sakhalin)	*Neanthes sakhalinensis* (Okuda, 1935)	Hartman (1959)
	59. N. shishidoi Izuka, 1912; (Japan)	*Cheilonereis cyclurus* (Harrington, 1897)	Okuda (1950)
	60. N. sinensis Wu, Sun & Yang, 1981; (China)	valid	Wu et al. (1985)
	61. N. singularis Treadwell, 1943; Khlebovich, 1996; (Atlantic Ocean)	*Ceratonereis mirabilis* Kingberg, 1866	Hartman (1956)
	62. N. surugaense Imajima, 1972; (Japan)	valid	Imajima (1972), Sato (2017)
	63. N. vexillosa sensu Annekova, 1937; Uschakov, 1965; Imajima, 1972; (Alaska and Siberia)	valid	Uschakov (1965); Imajima (1972); Sato (2017)
	64. N. zonata Malmgren, 1867; (Arctic Ocean)	valid	Sato (2017)
	65. N. z. tigrina Zachs, 1933; (Peter the Great Bay)	*N. tigrina* Zachs, 1933	Uschakov (1965)
Nicon	*66. N. japonicus* Imajima, 1972; (Japan)	valid	Imajima (1972), Sato (2017)
	67. N. misakiensis Imajima & Hayashi, 1969; (Japan)	*Rullierinereis misakiensis* (Imajima & Hayashi, 1969)	Wu & Sun (1979)
	68. N. moniloceras: Imajima, 1972; Wu et al., 1985; (England)	valid	Sato (2017)
	69. N. sinica Wu & Sun, 1979; (China)	valid	Wu & Sun (1979), Sato (2017)
Paraleonnates	*70. P. uschakovi* Khlebovich &Wu, 1962; (China)	valid	Hong et al. (2012)
Perinereis	*71. P. aibuhitensis sensu* Lee et al., 1992; (Palau)	*P. linea* (Treadwell, 1936)	Arias et al. (2013), present study
	72. P. brevicirris sensu Imajima & Hartman 1964; (Australia)	*P. mictodonta* (Marenzeller, 1879)	Glasby & Hsieh (2006)
	P. brevicirris sensu Wu 1967 (in part)	*P. shikueii* Glasby & Hsieh, 2006	Glasby & Hsieh (2006)
	73. P. camiguinoides Augener, 1922; Wu et al., 1985; (Juan Fernandez Is.)	valid	Wu et al. (1985)
	74. P. cultrifera floridana sensu Rho & Lee, 1982; Wu et al., 1985; Paik, 1989; (Florida)	*P. floridana* (Ehlers, 1868)	World Polychaeta database
	75. P. cultrifera typica sensu Wu et al., 1985; (?)	*P. cultrifera* (Grube, 1840)	from synonymy
	76. P. cultrifera var. *floridana sensu* Khlebovich & Wu, 1962; Uschakov & Wu, 1965; Imajima, 1972; (Florida)	*P. floridana* (Ehlers, 1868)	Read & Fauchald (2017)

Table 1. Continued.

Subfamily genus	Nominal names (Type locality)	Currently valid names	References
Perinereis	77. *P. cultrifera* var. *typica sensu* Khlebovich & Wu, 1962; Khlebovich, 1963; Uschakov & Wu, 1965; (Naples, Italy)	*P. cultrifera* (Grube, 1840)	from synonymy
	78. *P. helleri* (Grube, 1878); Wu, 1967; (Philippines)	valid	Wu (1967)
	79. *P. neocaledonica* Pruvot, 1930; Wu, 1967; Imajima et al. 1985; (New Caledonia)	valid	Sato (2017)
	80. *P. nigropunctata* (Horst, 1889); (Malaysia)	valid	Wu (1967)
	81. *P. novaehollandiae* Kinberg, 1866; Wu, 1967; (Australia)	*P. amblyodonta* (Schmarda, 1861)	Augener (1913)
	82. *P. nuntia* (Lamarck, 1818); Glasby & Hsieh, 2006; (Red Sea)	valid	Glasby & Hsieh, 2006
	P. nuntia sensu Paik, 1975	*P. mictodonta* (Marenzeller, 1879) or *P. wilsoni* Glasby & Hsieh, 2006	Park & Kim (2007)
	83. *P. nuntia brevicirris sensu* Wu et al., 1985; (Red Sea)	*P. mictodonta* (Marenzeller, 1879)	Glasby & Hsieh (2006)
	84. *P. nuntia* var. *brevicirris sensu* Okuda, 1938; Okuda & Yamada, 1954; Khlebovich & Wu 1962; Imajima, 1972; Paik, 1972; (Red Sea)	*P. mictodonta* (Marenzeller, 1879)	Glasby & Hsieh (2006), Park & Kim (2007)
	85. *P. nuntia* var. *vallata sensu* Khlebovich & Wu 1962; Paik 1972; Imajima 1972; (Chile)	*P. shikueii* Glasby & Hsieh, 2006	Glasby & Hsieh (2006)
	86. *P. shikueii* Glasby & Hsieh, 2006; (Taiwan)	valid	Glasby & Hsieh (2006), Salazar-Vallejo et al. (2014)
	87. *P. singaporiensis* Grube, 1878; Wu, 1967; (Singapore)	valid	Wu (1967)
	88. *P. suluana* (Horst, 1925); Tanaka, 2016; (Sulu Archipelago)	valid	Tanaka (2016), Sato (2017)
	89. *P. vancaurica* (Ehlers, 1868); Wu, 1967; (Nocobar Is.)	valid	Wu (1967)
	90. *P. vancaurica tetradentata* Imajima, 1972; (Japan)	valid	Imajima (1972)
	91. *P. wilsoni* Glasby & Hsieh, 2006; (Taiwan)	valid	Glasby & Hsieh (2006), Park & Kim (2007), Salazar-Vallejo et al. (2014), Sato (2017)
Periserrula	92. *P. leucophryna* Paik, 1977; (Korea)	*Paraleonnates uschakovi* Khlebovich &Wu, 1962	Hong et al. (2012)
Platynereis	93. *P. agassizi* (Ehlers, 1868) *sensu* Uschakov (1965); (US west coast)	*Platynereis bicanaliculata* (Baird, 1864)	Hartman (1956)
	94. *P. australis* (Schmarda, 1861); Imajima, 1972; (Australia)	valid	Imajima (1972), Sato (2017)
	95. *P. bicanaliculata* (Baird, 1864) *sensu* Wu, 1967; Imajima, 1972; Wu et al., 1985; Paik, 1977; (Canada)	valid	Imajima (1972); Sato (2017)

Table 1. Continued.

Subfamily genus	Nominal names (Type locality)	Currently valid names	References
Platynereis	*96. P. dumerilii* (Audouin and M. Edwards, 1834); Wu, 1967; Imajima, 1972; Wu et al., 1985; Paik, 1977; (France)	valid	Sato (2017)
Pseudonereis	*97. P. anomala* Gravier, 1901; Wu, 1967; (Australia)	valid	Wu (1967)
	98. P. formosa sensu Wu, 1967; (Hawaii)	*P. gallapagensis* Kinberg, 1866	Hartman (1938)
	99. P. gallapagensis Kinberg, 1866; Wu, 1967; Imajima, 1972; Wu et al., 1985; Paik, 1977; (Galapagos Is.)	valid	Wu (1967), Imajima (1972), Wu et al. (1985), Paik (1977), Sato (2017)
	100. P. rottnestiana Augener, 1913; Okuda, 1938; Imajima, 1972; (Australia)	*P. anomala* Gravier, 1901	Bakken (2007), Sato (2017)
	101. P. variegata sensu Imajima, 1972; Wu et al., 1985; Paik, 1977; Sato, 2017; (Chile)	valid	Imajima (1972); Sato (2017)
Rullierinereis	*102. R. elytrocirra* Wu & Sun, 1979; Wu et al., 1985; (China)	valid	Wu et al. (1985)
	103. R. profunda Imajima, 2009; (Japan)	valid	Imajima (2009), Sato (2017)
Sinonereis	*104. S. heteropoda* Wu & Sun, 1979; Wu et al., 1985; (China)	valid	Wu & Sun (1979), Wu et al. (1985)
Tylorrhynchus	*105. T. chinensis* Grube, 1866; Zachs, 1933; Uschakov, 1965; (China)	*T. heterochaetus* (Quatrefages, 1866)	Hartman (1959)

Table 2. A list of 27 selected species among 105 nominal species previously reported from Northeast Asian waters. Taxonomic reexamination for these species is conducted in chapter 1 and 2 from this study.

No.	Genus	Selected species	Type locality
	Alitta		
1		*A. brandti* Malmgren, 1865	Norway
	Cheilonereis		
2		*C. cyclurus* (Harrington, 1897)	Puget Sound, USA
	Hediste		
3		*H. atoka* Sato and Nakashima, 2003	Japan
4		*H. diadroma* Sato and Nakashima, 2003	Japan
5		*H. japonica* (Izuka, 1908)	Japan
	Nectoneanthes		
6		*N. oxypoda* (Marenzeller, 1879)	Japan
7		*N. uchiwa* Sato, 2013	Japan
	Nereis		
8		*N. denhamensis* Augener, 1913	Australia
9		*N. heterocirrata* Treadwell, 1931	Japan
10		*N. multignatha* Imajima and Hartman, 1964	Japan
11		*N. neoneanthes* Hartman, 1948	Alaska
12		*N.* (*Neanthes*) *orientalis* Treadwell, 1936	Amoy, China
13		*N. pelagica* Linnaeus, 1758	Weastern Europe
14		*N. tigrina* Zachs, 1933	Peter the Great Bay, Russia
15		*N. vexillosa* Grube, 1851	Alaska and Siberia
	Perinereis		
16		*P. aibuhitensis* (Grube, 1878)	Aibuhit, Palau
17		*P. cultrifera* (Grube, 1840)	Naples, Italy
18		*P. floridana* (Ehlers, 1868)	Florida, USA
19		*P. linea* (Treadwell, 1936)	Amoy, China
20		*P. mictodonta* (Marenzeller, 1878)	Japan
21		*P. shikueii* Glasby and Hsieh, 2006	Taiwan
22		*P. vancaurica tetradentata* Imajima, 1972	Sumida River, Japan
23		*P. wilsoni* Glasby and Hsieh, 2006	Taiwan
	Platynereis		
24		*P. bicanaliculata* (Baird, 1863)	Weastern Pacific, Canada
	Pseudonereis		
25		*P. anomala* Gravier, 1901	Australia
26		*P. formosa* Kinberg, 1866	Hawaii
27		*P. variegata* (Grube, 1857)	Chile

Morphology, Taxonomic Characters and Terminology of Nereidids

General Morphology

The body is elongated, rounded, and divided into a number of segments. In the light of external shape, the body consists of three regions: the head region, the trunk, and the pygidium.

1. Head

The head region located at the anterior end of the worm, composed of prostomium and peristomium. The prostomium is pear-shaped, bearing 4 eyes, at its anterior end there are pairs of palps and antennae. The peristomium is located at the segment just behind the prostomium, at its anterior end there are 4 pairs of tentacular cirri. The mouth is situated ventral surface of the peristomium. The proboscis is formed by the eversion of the buccal cavity and muscular pharynx of the gut, and composed of 2 rings, a maxillary and an oral ring. At the anterior end of the maxillary ring, there is a pair of black or brown horny jaws. Proboscis may be divided into eight areas. The areas on the maxillary ring are numbered from I to IV: dorsal median group I; 2 dorsal laterals II; ventral median III; 2 ventral laterals IV, and those oral ring from V to VIII: median dorsal V; 2 dorsal laterals VI; median ventrals VII–VIII. Each of areas bears chitinous paragnaths or soft papillae.

2. Trunk

It consists of a variable number of identical chaetigers and is situated posterior to the head region and anterior to the pygidium. Each of the body chaetigers has one pair of parapodia ending in fascicles of chaetae. Parapodia are pairs of fleshy, laterraly compossed projections from the body wall, it fulfills a locomotive function. In the light of differences in structure the parapodium can be devided into two types: biramous parapodium and uniramous parapodium. The biramous parapodium consists of dorsal division, the notopodium, and a ventral division, the neuropodium. Both are composed of one or more ligules and chaetal lobes bearing chaetae. The uniramous parapodium bears reduced notopodium, only the neuropodium left over. Chaetae are chitinous bristles situated on the outside and inside of the parapodia. They help to serve for locomotion.

3. Pygidium

The pygidium is situated at the extremely posterior end of the body. The anus opens dorsally at the end of the pygidium. The pygidium has one pair of long ventral cirri called anal cirri.

Taxonomic characters and terminology

Characters used in the taxonomy of nereidid species (Figs. 3–5).

1. Jaw

2. Paragnaths

    uniform-base paragnaths

    - pyramidial paragnah, conical paragnath, melted paragnath, rod-like paragnath

    rectangular-base paragnaths

    - smooth bar, shield-shaped bar, p-bar, ambiguous partly sclerotized papillae

3. Prostomium

    palp

    tentacular cirri (= peristomial cirri)

    antenna

4. Parapodium

    dorsal cirrus, notopodial dorsal ligule, dorsal collar, notopodial prechaetal lobe, notopodial postchaetal lobe, notoacicular papilla, notoaciculum, notopodial ventrial ligule, ventral collar, superior lobe, neuroacicular papilla, neuroaciculum, inferior lobe, neuropodial prechaetal lobe, neuropodial postchaetal lobe, neuropodial ventral ligule, ventral cirrus

5. Chaetae

    homogomph spiniger, homogomph falciger

    heterogomph spiniger, heterogomph falciger

    sesquigomph spiniger, sesquigomph falciger

    fused falciger (=simple chaeta)

6. Pigmentation

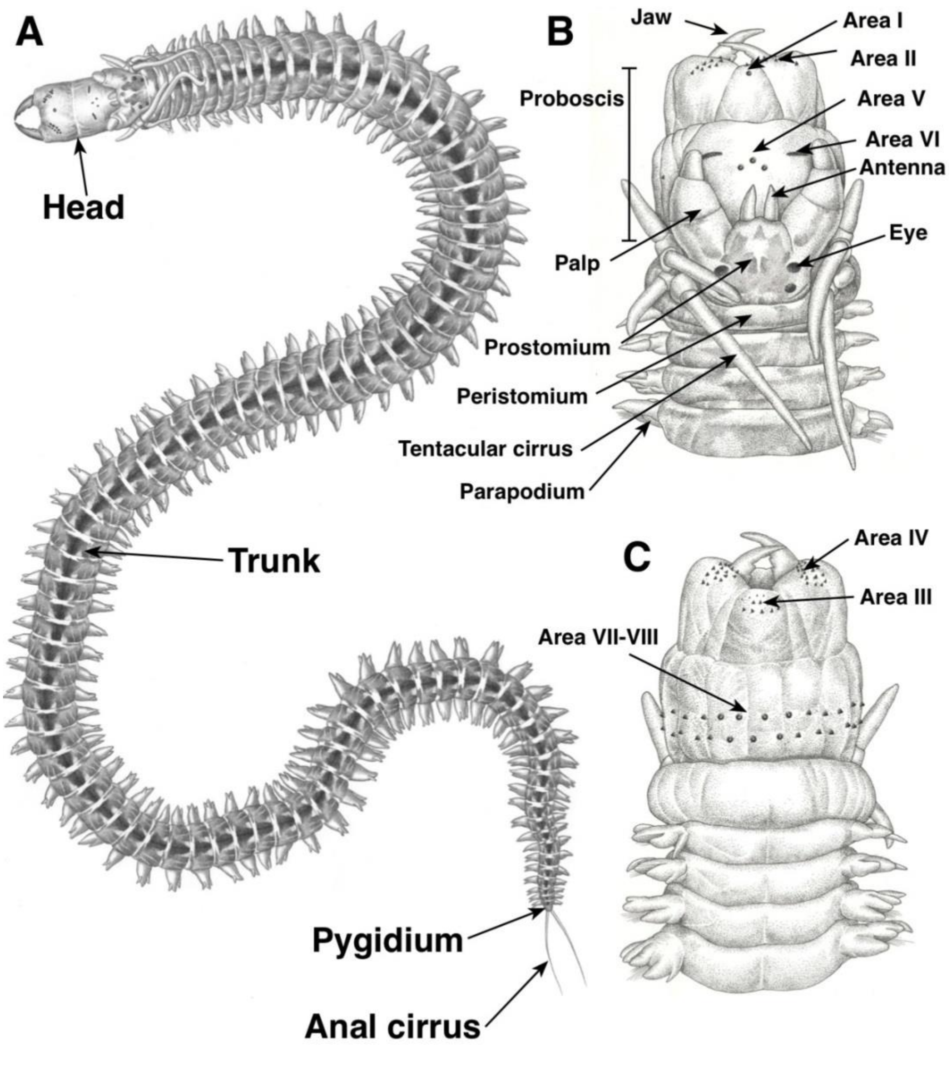

Fig. 3. Taxonomic characters of nereidids. (A) Habitus; (B) Dorsal view of anterior part; (C) Ventral view of anterior part.

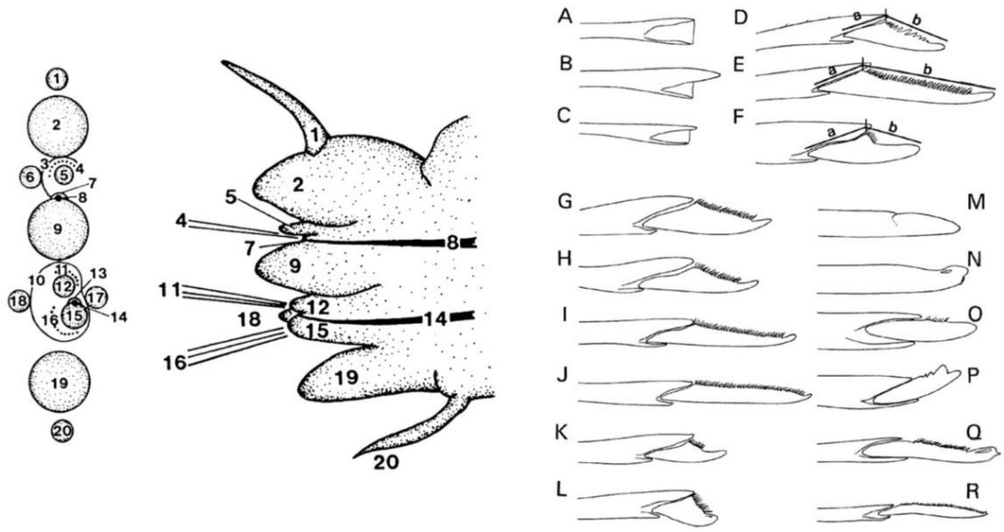

Fig. 4. 1–20. Terminology of parapodial features in generalized nereidid. (1) dorsal cirrus; (2) notopodial dorsal ligule; (3) dorsal collar; (4) notochaetae; (5) notopodial prechaetal lobe; (6) notopodial postchaetal lobe; (7) notoacicular papilla; (8) notoaciculum; (9) notopodial ventral ligule; (10) ventral collar; (11) upper neurochaetae; (12) superior lobe; (13) neuroacicular papilla; (14) neuroaciculum; (15) inferior lobe; (16) lower neurochaetae; (17) neuropodial prechaetal lobe; (18) neuropodial postchaetal lobe; (19) neuropodial ventral ligule; (20) ventral cirrus. A–R. Chaetae from representative Nereidinae genera. (A) Homogomph spiniger shaft; (B) Heterogomph falciger shaft; (C) Sesquigomph falciger shaft; (D) Medium heterogomph falciger; (E) Long heterogomph falciger; (F) Short heterogomph falciger; (G, H) Medium falciger; (I, J) Long falciger; (K, L) Short falciger; (M, N) Fused falciger (Simple chaeta); (O–Q) Notopodial homogomph falciger; (R) Notopodial sesquigomph falciger. Modified from Hylleberg et al. (1986: fig. 1) and Bakken and Wilson (2005: figs. 4, 5).

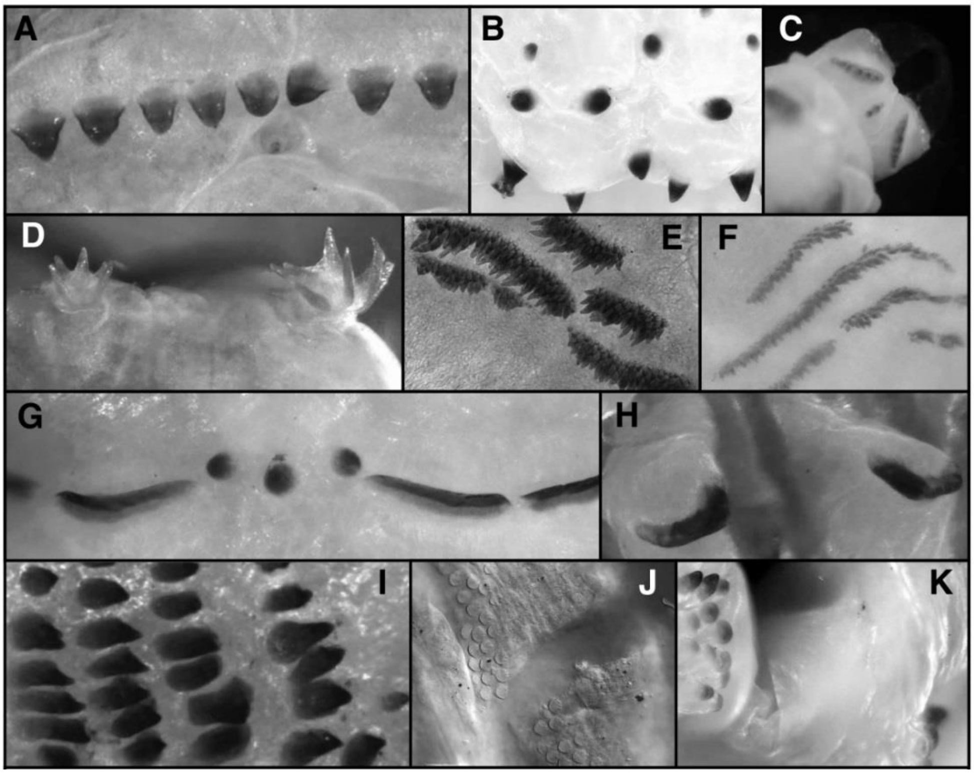

Fig. 5. Terminology of paragnath features in generalized nereidid. (A) Pyramidal paragnath; (B) conical paragnaths (cones); (C) melted paragnath; (D–F) rod-like paragnath; (G) smooth bars; (H) shield-shaped bars; (I) p-bars (pointed bars); (J) crown-shaped paragnaths; (K) partly sclerotized papillae. Modified from Bakken et al. (2009: figs. 2–5).

CHAPTER 1.

Molecular Taxonomic Study of Selected Northeast Asian Nereidids

1.1. Introduction

Molecular based tools have been applied for species identification and resolving species boundaries in populations of morphologically similar organisms. These tools are particularly useful for marine organisms with poor understanding of species boundaries and broad-scale distribution (Carr et al., 2011). Some researchers have used as much data as possible to distinguish morphologically similar species, including characteristics of ecology, physiology, morphology, and molecular data (Sato and Nakashima, 2003; Capa et al., 2010; Nygren et al., 2010). However, it is sometimes inefficient to obtain all these data.

Recently, taxonomic studies for nereidid species have indicated the existence of unnamed species and those species were reported as new species combined with their molecular and morphological analises (Chen et al., 2002; Glasby and Hsieh, 2006; Park and Kim, 2007; Glasby et al., 2013). These studies demonstrate that conventional taxonomic approaches often overlook misidentified or cryptic species. Therefore, integrated taxonomic approaches using morphological and molecular data are useful for delineating species boundaries.

Generally, partial genes of mitochondrial cytochrome c oxidase subunit I (COI), mitochondrial 16S ribosomal RNA (16S rRNA), nuclear histone H3 (H3), and ribosomal internal transcribed spacers (ITS) are useful to discriminate species (Chen et al., 2002; Hebert et al., 2003; Park and Kim, 2007; Carr et al., 2011; Tosuji and Sato, 2012; Glasby et al., 2013; Nygren, 2014). Of these genes, COI has important advantages. Alignment of COI sequences is straightforward as indels are uncommon. COI sequences possess a high level of diversity. Universal primers for this gene are very robust, enabling recovery of its 5′ end from representatives of most animal phyla (Folmer et al., 1994; Zhang and Hewitt, 1997; Hebert et al., 2003).

In this study, ‘reverse taxonomic’ approach (Markmann and Tautz, 2005) was applied using COI sequences to evaluate taxonomic status of selected nereidid species from Northeast Asia. A total of 234 sequences of COI from 32 nereidid taxa were used to compare COI sequences. Twenty-two species among 27 selected nereidid from Northeast Asia (Table 2) were included for comparison (Table 4, 5).

1.2. Materials and Methods

1.2.1. Collection and Sample processing

Nereidid worms were collected from various habitats, including intertidal mud, sand flats, under boulder in beaches, among sessile organisms attached to both intertidal and subtidal rocky areas, and mangrove forest in estuary areas (Fig. 6, Table 4). For each habitat, various collecting methods were used. Mud flat was dug with a shovel. Sessile organisms in rocky area were picked with a digging knife during low tide in intertidal and mangrove areas. In the case of subtidal rocky areas, sessile organisms were collected by SCUBA diving. Sometimes, technical diving was performed using specialized diving gears and breathing gases (such as diver propulsion vehicle, twin-set cylinders filled trimix gas consisting of oxygen, helium, and nitrogen, and decompression oxygen cylinder) to extend underwater collecting time and diving depth. Collected samples were rinsed with seawater in a bucket. Worms were separated from sessile organisms by sieving. To make worms' proboscis evert, 7% $MgCl_2$ was added for anaesthetization. Slight pressure was applied to their pharyngeal region. Worms were then fixed in 80% ethanol for both morphological and molecular studies. Comparative specimens were collected from intertidal areas of Cambodia (Koh Rung Samloem Island), Australia (Darwin, Northern Territory), Singapore (St. John's Island), and Palau (Melekeok) (Fig. 6, Table 5) with the same collecting and processing methods as described above.

1.2.2. DNA extraction, PCR amplification, and molecular analysis

A total of 184 individuals of 22 species from Northeast Asian waters were subjected to genomic DNA extraction. Total genomic DNA was extracted from ventral soft tissue using DNeasy Blood and Tissue Kit (Qiagen, Valencia, CA, USA) following the manufacturer's instructions. PCR amplifications were conducted using gene specific primer sets shown in Table 3. PCR thermal cycling condition was: 94°C for 30 sec; 35 cycles of 98°C for 10 sec, 47°C for 30 sec, and 72°C for 1 min; and a final extension at 72°C for 10 min. Amplified PCR products were purified using QIAquick PCR purification Kit (Qiagen, Valencia, CA, USA). Sequencing reaction containing each primer was prepared using BigDye Terminator ver. 3.1 Cycle Sequencing Kit (Applied Biosystems, Foster City, CA, USA) followed by sequencing PCR. PCR products were then analyzed using an ABI 3730 sequencer (Applied Biosystems, Foster City, CA, USA). Products were sequenced in both directions. Obtained sequences were then aligned using MUSCLE in Geneious ver. 9 (Biomatter Co.). Pairwise distances were calculated using Kimura-2-parameter model (Kimura, 1980). Phylogenetic tree was constructed using Neighbor joining method with 1000 times of bootstrap resampling in MEGA ver. 7 (Kumar et al., 2016).

Table 3. Primer sequences.

Gene	Primer	Reference
COI		
LCO1490(F)	GGT CAA CAA ATC ATA AAG ATA TTG G	Former et al. (1994)
HCO2198(R)	TAAACT TCA GGG TGA CCA AAA AAT CA	
polyLCO(F)	GAY TAT WTT CAA CAA TAC ATA AAG ATA TTG G	Carr et al. (2011)
polyHCO(R)	TAM ACT TCW GGG TGA CCA AAR AAT CA	
polyshortCOIR(R)	CCN CCT CCN GCW GGR TCR AAR AA	
15F(F)	AYG CAA CGA TGA YTY TTY TC	present study
19R(R)	ATR TGW GAR AYT ATR CCR AA	
16F(F)	AAA GAY ATY GGW ACM YTA TA	
18R(R)	TAR ACY TCW GGR TGM CCR AAR AAY CA	

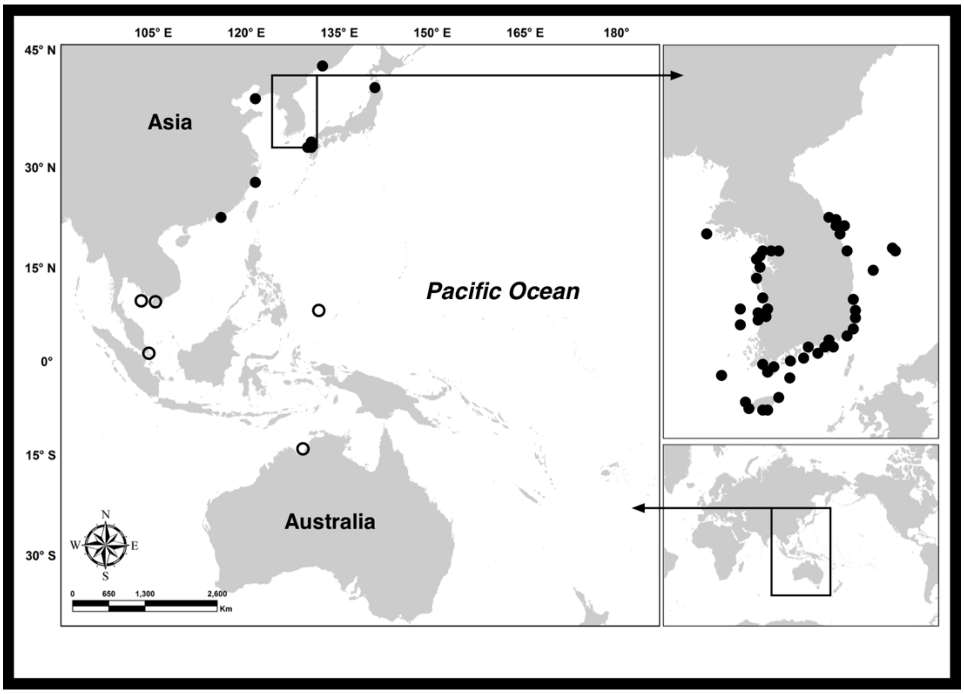

Fig. 6. Collecting sites of the present study. (●): Collecting sites for Northeast Asian species. (○) Collecting sites for comparative species.

Table 4. Taxa and specimens from Northeast Asian waters used for molecular phylogenetic analyses (species name in parentheses are revised species name in chapter 2 of the present study).

Taxon	**Sequence initial (n = individuals)**	**Locality**	**Voucher**
1. *Alitta brandti* (*Alitta* cf. *brandti*)			
	NvMuk (n=1)	Korea (Mukho Harbor)	NIBRIV0000787925
2. *Cheilonereis cyclurus* (*Cheilonereis shishidoi*)			
	CheGa1 (n=1)	Korea (Gajin Harbor)	NIBRIV0000787932
	CheGa2 (n=1)	Korea (Gajin Harbor)	NIBRIV0000787933
	CheGa3 (n=1)	Korea (Gajin Harbor)	NIBRIV0000787934
3. *Composetia* sp. nov.			
	Nji (n=1)	Korea (Jejudo Is.)	NIBRIV0000783690
	Nwul (n=1)	Korea (Ulleungdo Is.)	NIBRIV0000783691
4. *Hediste atoka*			
	Hjgeoje (n=8)	Korea (Geojedo Is.)	NIBRIV0000787278
	Hjkpo (n=5)	Korea (Kyungpoho Lake)	NIBRIV0000781336
	Hjnam (n=5)	Korea (Namdaecheon River)	NIBRIV0000787279
	Hjosip (n=8)	Korea (Osipcheon River)	NIBRIV0000787280
	Hjsehwa (n=3)	Korea (Jejudo Is.)	NIBRIV0000787277
	Hjsehwa2 (n=1)	Korea (Jejudo Is.)	NIBRIV0000787277
	Hjsehwa4 (n=1)	Korea (Jejudo Is.)	NIBRIV0000787277
	Hjwangpi (n=3)	Korea (Wangpicheon River)	NIBRIV0000787275
	Hatoshin (n=2)	Japan (Shinjo River)	NIBRIV0000787276
5. *Hediste diadroma*			
	Hdiaomoi2 (n=1)	Japan (Omoigawa River)	NIBRIV0000787271
	Hdiasai (n=1)	Japan (Saigogawa River)	NIBRIV0000787272
	Hjhach (n=4)	Korea (Geojedo Is.)	NIBRIV0000787274
	Hdiachil (n=1)	Korea (Chilcheondo Is.)	NIBRIV0000783847
6. *Hediste japonica*			
	HjYpis (n=2)	Korea (Yeonpyeongdo Is.)	NIBRIV0000783706
	HjAri (n=4)	Japan (Omutagawa River)	NIBRIV0000783705
	HjDongmak (n=4)	Korea (Ganghwado Is.)	NIBRIV0000244195
Hediste japonica (*Hediste* sp.)			
	HnGeom (n=3)	Korea (Incheon-si)	NIBRIV0000787892
	Hjgeom (n=2)	Korea (Incheon-si)	NIBRIV0000787894
	HnGong (n=3)	Korea (Gongneungcheon River)	NIBRIV0000787891
	HjHannew (n=1)	Korea (Hangang River)	NIBRIV0000801062
7. *Nectoneanthes oxypoda*			
	NecoxyG1 (n=1)	Korea (Chwido Is.)	NIBRIV0000787923

Table 4. Continued.

Taxon	Sequence initial (n = individuals)	Locality	Voucher
8. *Nectoneanthes uchiwa*			
	NecuM (n=3)	Korea (Mongsanpo Port)	NIBRIV0000787900
9. *Nereis heterocirrata*			
	NhGwang (n=3)	Korea (Gwangyangman Bay)	NIBRIV0000801044
	NhPohang (n=1)	Korea (Yeongilman Bay)	NIBRIV0000801029
	NspOng (n=1)	Korea (Yeongheungdo Is.)	NIBRIV0000266689
10. *Nereis pelagica* (*Nereis* aff. *pelagica*)			
	NpGo (n=1)	Korea (Goseong-gun, East Sea)	NIBRIV0000783698
	NpMun1 (n=1)	Korea (Goseong-gun, East Sea)	NIBRIV0000783694
11. *Nereis denhamensis* (*Nereis* sp. nov. 1)			
	NpWang (n=2)	Korea (Wangdolcho Reef)	NIBRIV0000783663
	NpWu (n=1)	Korea (Wudo Is., Jeju-do)	NIBRIV0000806647
	NspGa (n=1)	Korea (Gapado Is., Jeju-do)	NIBRIV0000783666
	NdenJ2 (n=1)	Korea (Jejudo Is.)	NIBRIV0000783670
12. *Nereis* sp. nov. 2			
	NspWang1 (n=1)	Korea (Wangdolcho Reef)	NIBRIV0000801027
	NspWang2 (n=1)	Korea (Wangdolcho Reef)	NIBRIV0000781332
	NspDDC (n=1)	Korea (Yangyang-gun)	NIBRIV0000801028
13. *Nereis multignatha* (*Nereis* sp. nov. 3)			
	NmulTy1 (n=1)	Korea (Tongyeong-si)	NIBRIV0000783838
	NmulTy2 (n=1)	Korea (Tongyeong-si)	NIBRIV0000783837
	NmulImpo (n=1)	Korea (Yeosu-si)	NIBRIV0000783836
	NmulGeo (n=1)	Korea (Geojedo Is.)	NIBRIV0000165647
	NmulOi (n=1)	Korea (Oemaemuldo Is.)	NIBRIV0000810283
14. *Nereis neoneanthes* (*Nereis multignatha*)			
	NneoWang2 (n=1)	Korea (Wangdolcho Reef)	NIBRIV0000810284
	NneoWang3 (n=1)	Korea (Wangdolcho Reef)	NIBRIV0000810284
	NneoYeo (n=4)	Korea (Yeosu-si)	NIBRIV0000810294
	NmulYang1 (n=1)	Korea (Yangyang-gun)	NIBRIV0000783815
15. *Nereis tigrina*			
	NeYa (n=1)	Korea (Yangyang-gun)	NIBRIV0000783845
	NspYang1 (n=1)	Korea (Yangyang-gun)	NIBRIV0000783821
	NspOa (n=1)	Korea (Yangyang-gun)	NIBRIV0000783846
	NspYang (n=1)	Korea (Yangyang-gun)	NIBRIV0000783820
	NspYa (n=3)	Korea (Yangyang-gun)	NIBRIV0000545848
	NezDong (n=1)	Korea (Donghae-si)	NIBRIV0000801063
16. *Perinereis cultrifera* (*Perinereis euiini*)			
	Pcgeoje (n=3)	Korea (Geojedo Is.)	NIBRIV0000502105
17. *Perinereis linea*			
	PaJa (n=3)	Japan (Shirahama, fishing shop)	NIBRIV0000810290
	Pljeongok (n=3)	Korea (Jeongok-ri)	NIBRIV0000810291

Table 4. Continued.

Taxon	Sequence initial (n = individuals)	Locality	Voucher
18. *Perinereis mictodonta*			
	Pnbiin4 (n=1)	Korea (Biin Harbor)	NIBRIV0000810295
	Pnbiin6 (n=1)	Korea (Biin Harbor)	NIBRIV0000810295
	Pnbiin22 (n=1)	Korea (Biin Harbor)	NIBRIV0000810295
	Pnbiin14 (n=1)	Korea (Biin Harbor)	NIBRIV0000810295
	Pnbiin (n=5)	Korea (Biin Harbor)	NIBRIV0000810295
	PmicAria (n=1)	Japan (Ariake Sea)	NIBRIV0000787944
	PmicSai (n=1)	Japan (Saigogawa River)	NIBRIV0000787943
	PmicSai1 (n=1)	Japan (Saigogawa River)	NIBRIV0000787942
	PnYounp (n=3)	Korea (Yeonpyungdo Is.)	NIBRIV0000787941
	PsJ (n=8)	Korea (Seonjedo Is.)	-
19. *Perinereis shikueii*			
	PmicNana (n=1)	Japan (Nanaura)	NIBRIV0000787945
	PmicNaka (n=3)	Japan (Nanaura)	-
20. *Perinereis wilsoni* (*Perinereis wilsoni* species complex)			
	Pncnew1 (n=1)	Korea (Chilcheondo Is.)	NIBRIV0000810293
	Pncnew2 (n=1)	Korea (Chilcheondo Is.)	NIBRIV0000810293
	Pncnew4 (n=1)	Korea (Chilcheondo Is.)	NIBRIV0000810293
	PnJh (n=3)	Korea (Jejudo Is.)	-
	PnJojo (n=4)	Korea (Jejudo Is.)	NIBRIV0000787935
	PwilYul (n=2)	Korea (Geomundo Is.)	NIBRIV0000801058
	PmSin (n=2)	Japan (Sinkawa River)	NIBRIV0000787937
	Pnbiin2 (n=1)	Korea (Biin Harbor)	NIBRIV0000810296
	PnC9 (n=1)	Korea (Chilcheondo Is.)	-
	Pncnew3 (n=1)	Korea (Chilcheondo Is.)	NIBRIV0000801061
	Pnepitoky (n=1)	Korea (Gangu Harbor)	NIBRIV0000801060
	PspHong (n=5)	Hong Kong (Lamma Is.)	NIBRIV0000787936
21. *Platynereis bicanaliculata* (*Platynereis* sp. 1)			
	PlatUl1 (n=1)	Korea (Ulleungdo Is.)	NIBRIV0000787912
	PlatYeo1 (n=1)	Korea (Geomundo Is.)	NIBRIV0000787917
Platynereis bicanaliculata (*Platynereis* sp. 2)			
	NspYung (n=1)	Korea (Yangyang-gun)	NIBRIV0000787909
	PlbSeo (n=1)	Korea (Geomundo Is.)	NIBRIV0000787916
	PblYul (n=1)	Korea (Geomundo Is.)	NIBRIV0000787914
	PlbGa1 (n=1)	Korea (Gapado Is.)	NIBRIV0000787911
	PlbGa2 (n=1)	Korea (Gapado Is.)	NIBRIV0000787913
	PblDok (n=1)	Korea (Dokdo Is.)	NIBRIV0000787918
	PlbOi (n=2)	Korea (Oedo Is.)	NIBRIV0000787915

Table 4. Continued.

Taxon	Sequence initial (n = individuals)	Locality	Voucher
22. *Pseudonereis variegata* (*Pseudonereis* sp. nov.)			
	PseudoAya (n=1)	Korea (Ayajin)	-
	PseudoHong (n=1)	Hong Kong (Lamma Is.)	NIBRIV0000787901
	PvJp1 (n=1)	Japan (Aburatsu Port)	NIBRIV0000783832
	PvJp2 (n=1)	Japan (Aburatsu Port)	NIBRIV0000783833
	PvPohang (n=2)	Korea (Pohang-si)	NIBRIV0000783858
	PvUlsan (n=2)	Korea (Ulsan-si)	NIBRIV0000783857

1.2.3. Comparative DNA sequencing and data mining

A total of 50 comparative DNA sequences in 22 taxa were sequenced or mined from GenBank and BOLD (Table 5) based on the following criteria: (1) DNA sequence was obtained from type locality or at least close to the type locality of each species, (2) DNA sequence was obtained during taxonomic research by nereidid taxonomist, (3) DNA sequences were obtained from specimens collected in Northeast Asia when the taxon required comparison with its type specimen and the present specimen.

Table 5. Comparative DNA sequences for molecular phylogenetic analyses (species name in parentheses are revised species name in chapter 2 of the present study).

Taxon Initial	Locality	Accession No.	Database	References
1. *Alitta virens*				
Avirens	Canada (Atlantic)	KM612233	GenBank	Dewaard et al.*
	Canada (Atlantic)	HQ023960	GenBank	Carr et al. (2011)
	Russia (West)	GU672464	GenBank	Hardy et al. (2011)
2. *Alitta succinea*				
Asuccinea	Germany (Central Wadden Sea)	KX537503	GenBank	Villalobos-Guerrero and Carrera-Parra (2015)
3. *Cheilonereis cyclurus*				
Ccyclurus	Canada (Pacific)	HM473330	GenBank	Carr et al. (2011)
4. *Hediste atoka*				
Hatoka	Japan	AB603842	GenBank	Tosuji and Sato (2010)
5. *Hediste diadroma*				
Hdiadroma	Japan	AB996739	Genbank	Tosuji and Furota (2016)
6. *Hediste japonica*				
Hjaponica	Japan	AB603758	GenBank	Tosuji and Sato (2010)
7. *Nereis denhamensis*				
Ndenhamensis	Australia	JX392063	GenBank	Glasby et al. (2013)
8. *Nereis heterocirrata*				
Nheterocirrata	China	KC800626	GenBank	Deng*
9. *Nereis pelagica*				
Npelagica1	Russia (West)	GU672449	GenBank	Hardy et al. (2011)
Npelagica2	USA (Alaska)	HM473777	GenBank	Carr et al. (2011)
Npelagica3	Portugal	KR916896	GenBank	Lobo et al. (2016)

*Unpublished

Table 5. Continued.

Taxon Initial	Locality	Accession No.	Database	References
10. *Nereis vexillosa*				
Nvexillosa1	Canada (Pacific)	HM473507	GenBank	Carr et al. (2011)
Nvexillosa2	Canada (Pacific)	HM473506	GenBank	Carr et al. (2011)
Nereis vexillosa (*Nereis* sp. nov. 4)				
Nvexillosa3	China	HZPLY099-12	BOLD	Hong*
11. *Nereis zonata*				
Nzonata1	Canada (Arctic)	HQ024405	GenBank	Carr et al. (2011)
Nzonata2	Canada (Arctic)	HQ024402	GenBank	Carr et al. (2011)
12. *Perinereis aibuhitensis*				
PaPaM1	Palau	-	-	present study
PaPaM2	Palau	-	-	present study
PaPaM3	Palau	-	-	present study
13. *Perinereis cultrifera* (*Perinereis euiini*)				
Pcultrifera1	China	KC800624	GenBank	Deng*
Pcultrifera2	China	KC800625	GenBank	Deng*
Pcultrifera3	China	KC800627	GenBank	Deng*
Perinereis cultrifera				
Pcultrifera4	Portugal	KR916910	GenBank	Lobo et al. (2016)
Pcultrifera5	Portugal	KR916911	GenBank	Lobo et al. (2016)
Pcultrifera6	Portugal	KR916912	GenBank	Lobo et al. (2016)
14. *Perinereis rhombodonta*				
Prhom1	Cambodia	-	-	present study
Prhom2	Cambodia	-	-	present study
Prhom3	Cambodia	-	-	present study
15. *Perinereis singaporiensis*				
PsiD1	Australia	-	-	present study
PsiD2	Australia	-	-	present study
PsiD3	Australia	-	-	present study
16. *Perinereis vallata*				
Pval1	Australia	-	-	present study
Pval2	Australia	-	-	present study
17. *Perinereis wilsoni*				
Pwilsoni1	China	KY129888	GenBank	Chen et al. (2002)
Pwilsoni2	China	KC800631	GenBank	Deng*

*Unpublished

Table 5. Continued.

Taxon Initial	Locality	Accession No.	Database	References
18. *Platynereis bicanaliculata*				
Pbicanaliculata2	Canada (Pacific)	HM473598	GenBank	Carr et al. (2011)
Pbicanaliculata4	Canada (Pacific)	HM473589	GenBank	Carr et al. (2011)
Pbicanaliculata5	Canada (Pacific)	HM473595	GenBank	Carr et al. (2011)
Platynereis bicanaliculata (*Platynereis* sp. 2)				
Pbicanaliculata1	China	KY129884	GenBank	Chen et al. (2002)
Pbicanaliculata3	China	GU362685	GenBank	Zhou et al. (2010)
Pbicanaliculata6	China	HZPLY605-13	BOLD	Hong*
Pbicanaliculata7	China	HZPLY613-13	BOLD	Hong*
19. *Platynereis dumerilii*				
Pdumerilii2	France	KT124703	GenBank	Waege et al.*
20. *Pseudonereis anomala*				
Panomala1	Australia	JX420267	GenBank	Glasby et al. (2013)
21. *Pseudonereis gallapagensis*				
Pgallapagensis	Colombia	JF293309	GenBank	Hererra et al.*
22. *Pseudonereis variegata*				
Pvariegata1	Chile	HQ705197	GenBank	Sampertegui et al.*
Pseudonereis variegata (*Pseudonereis* sp. nov.)				
Pvariegata2	China	KY129880	GenBank	Chen et al. (2002)
Pvariegata3	China	KC800622	GenBank	Deng*

*Unpublished

1.3. Results

1.3.1. COI genetic distances

Pairwise genetic distances of 'within species' for 33 nereidid species are listed in Table 6. High P-distance values of 'within species' comparison were detected for 10 species (*Perinereis wilsoni* Glasby and Hsieh, 2006; *P. cultrifera* (Grube, 1840); *Pseudonereis variegata* (Grube, 1857); *Hediste japonica* (Izuka, 1908); *Nereis denhamensis* (Augener, 1913); *N. vexillosa* Grube, 1851; *N. pelagica* Linnaeus, 1758; *N. multignatha* Imajima and Hartman, 1964; *Platynereis bicanaliculata* (Baird, 1863); *Cheilonereis cyclurus* (Harrington, 1897)). In contrast, 22 nereidid species showed low P-distance values of 'within species' comparison. Generally, a low P-distance value is indicative of specimens from the same species while a high P-distance value is indicative of specimens from different species. Thus, these 10 species that showed high P-values of 'within species' comparison were considered as different species.

1.3.2. Phylogenetic tree based on COI sequences

Phylogenetic analysis showed that 33 nereidid species represented 42 distinctive clades. Among these, 10 species (1. *Perinereis wilsoni*, 2. *P. cultrifera*, 3. *Pseudonereis variegata*, 4. *Hediste japonica*, 5. *Nereis denhamensis*, 6. *Platynereis bicanaliculata*, 7. *Nereis multignatha*, 8. *Cheilonereis cyclurus*, 9. *Nereis vexillosa*, and 10. *N. pelagica*) were separated into two or more clades (Fig 7), indicating the presence of undescribed species.

1. *Perinereis wilsoni* was represented by more than two clades (A). All specimens in clade A were from Northeast Asia. Hence, *P. wilsoni* seems to be a species complex group.

2. *Perinereis cultrifera* was represented by clades B and D. Specimens in clade B were from Portugal near the type locality (Naples, Italy) of *P. cultrifera*. Hence, clade D (specimens from Northeast Asia) is likely to represent undescribed species.

3. *Pseudonereis variegata* was represented by two clades of C and I. Specimen in clade I was from Chile, the type locality of this species. Hence, clade C (specimens from Northeast Asia) is likely to represent undescribed species.

4. *Hediste japonica* included two clades (E and F). All specimens in clades E and F were from Northeast Asia. Topotype specimen was included in Clade E. Hence, clade F is likely to indicate new cryptic species.

5. *Nereis denhamensis* was represented by clades G and R. Specimen in clade G was from Australia, the type locality of this species. Hence, clade R (specimens from Northeast Asia) is likely to represent undescribed species.

6. *Platynereis bicanaliculata* was represented by three clades (H, J, K). Specimens in clade K were from Canadian coast of western Pacific, the type locality of this species. Hence, clades H and J (specimens from Northeast Asia) are likely to represent two new cryptic species.

7. *Nereis multignatha* was represented by two clades (L, M). Specimens of *N. neoneanthes* Hartman, 1948 from Northeast Asia was included in clade M. Hence, clades L and M might indicate compositions of cryptic species.

8. *Cheilonereis cyclurus* was represented by two clades of N and O. Specimen in clade N was from Canadian coast of western Pacific near the type locality (Puget Sound bays, USA) of this species. Hence, clade O (specimens from Northeast Asia) is likely to represent undescribed species.

9. *Nereis vexillosa* was represented by clades P and Q. Specimen in clade Q was from Canadian coast of western Pacific near the type locality (Alaska and Siberia) of this species. Hence, clade P (specimen from Northeast Asia) is likely to represent undescribed species.

10. *Nereis pelagica* was represented by two clades of S and T. Specimens in clade T were from Russia, USA, and Portugal. Hence, clade S (specimens from Northeast Asian) is likely to represent undescribed species.

Table 6. Pairwise genetic distance (K2P distance) of 'within species' based on 658 positions of COI sequences for 33 nereidid species (species name marked with an asterisk (*) indicates a species with a high P-distance value of 'within species').

Species	**P-distance range of "within species"**	**Species**	**P-distance range of "within species"**
Alitta succinea (n=1)	-	**N. vexillosa* (n=3)	0–0.205
A. virens (n=3)	0	*N. zonata* (n=2)	0
A. brandti (n=1)	0	*Perinereis aibuhitensis* (n=3)	0–0.003
**Cheilonereis cyclurus* (n=4)	0–0.173	**P. cultrifera* (n=9)	0–0.226
Composetia sp. nov. (n=2)	0.017	*P. linea* (n=6)	0–0.014
Hediste atoka (n=37)	0–0.037	*P. mictodonta* (n=23)	0–0.011
H. diadroma (n=8)	0–0.025	*P. rhombodonta* (n=3)	0–0.003
**H. japonica* (n=20)	0–0.197	*P. shikueii* (n=4)	0
Nectoneanthes oxypoda (n=1)	-	*P. singaporiensis* (n=3)	0.003–0.005
N. uchiwa (n=3)	0	*P. vallata* (n=2)	0.005
**Nereis denhamensis* (n=6)	0–0.271	**P. wilsoni* (n=25)	0–0.097
N. heterocirrata (n=6)	0–0.005	**Platynereis bicanaliculata* (n=17)	0–0.26
**N. pelagica* (n=5)	0–0.129	*Platynereis dumerilii* (n=1)	-
N. sp. nov. 2 (n=3)	0–0.008	*Pseudonereis anomala* (n=1)	-
**N. multignatha* (n=5)	0–0.154	*P. galapagensis* (n=1)	-
N. neoneanthes (n=7)	0	**P. variegata* (n=11)	0–0.23
N. tigrina (n=8)	0–0.003		

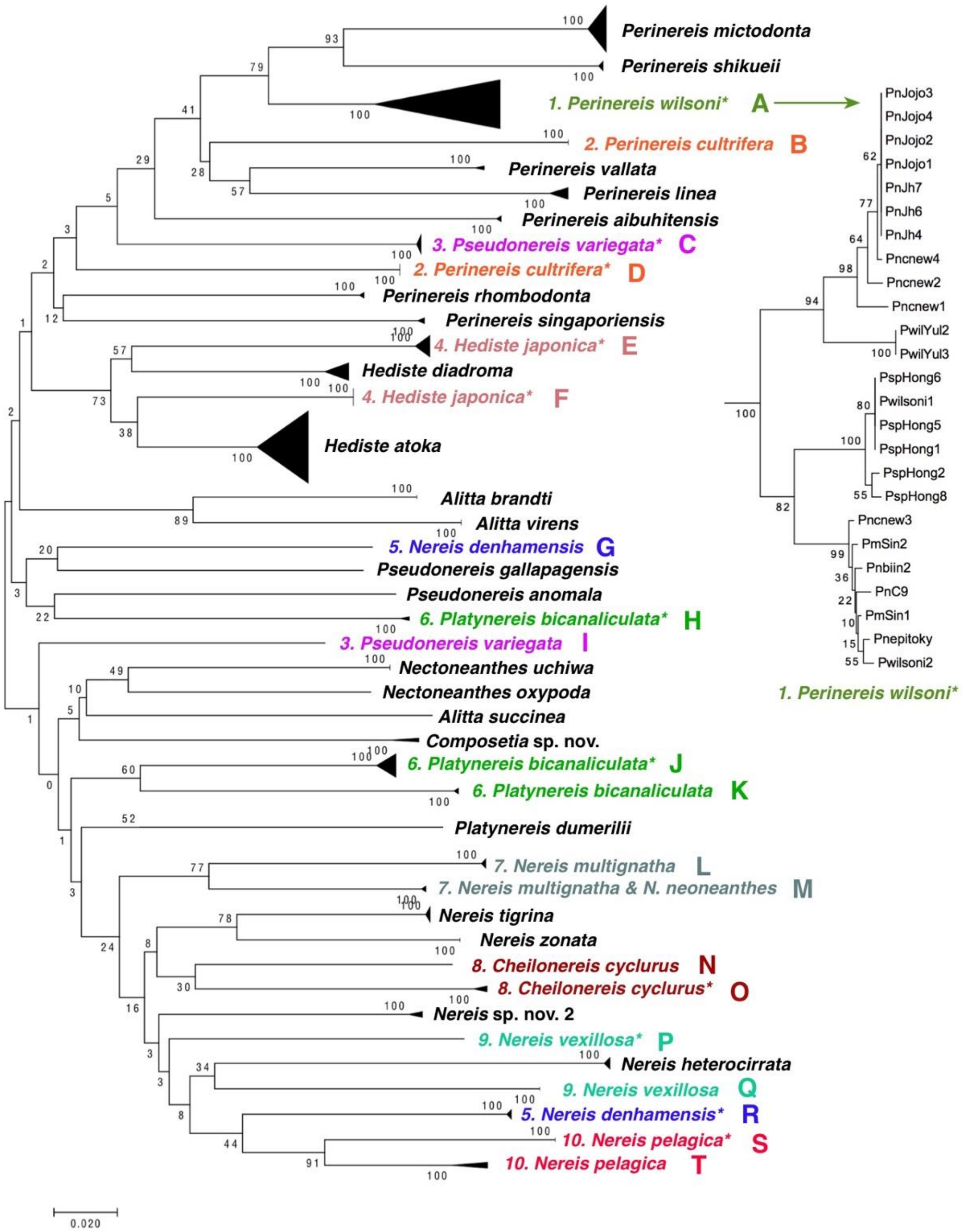

Fig. 7. Neighbor joining tree using COI sequences for 33 nereidid species. The species name marked with an asterisk (*) indicates selected taxa from Northeast Asia reexamined in this chapter. Species name with the same color and number indicate species separated into two or more clades.

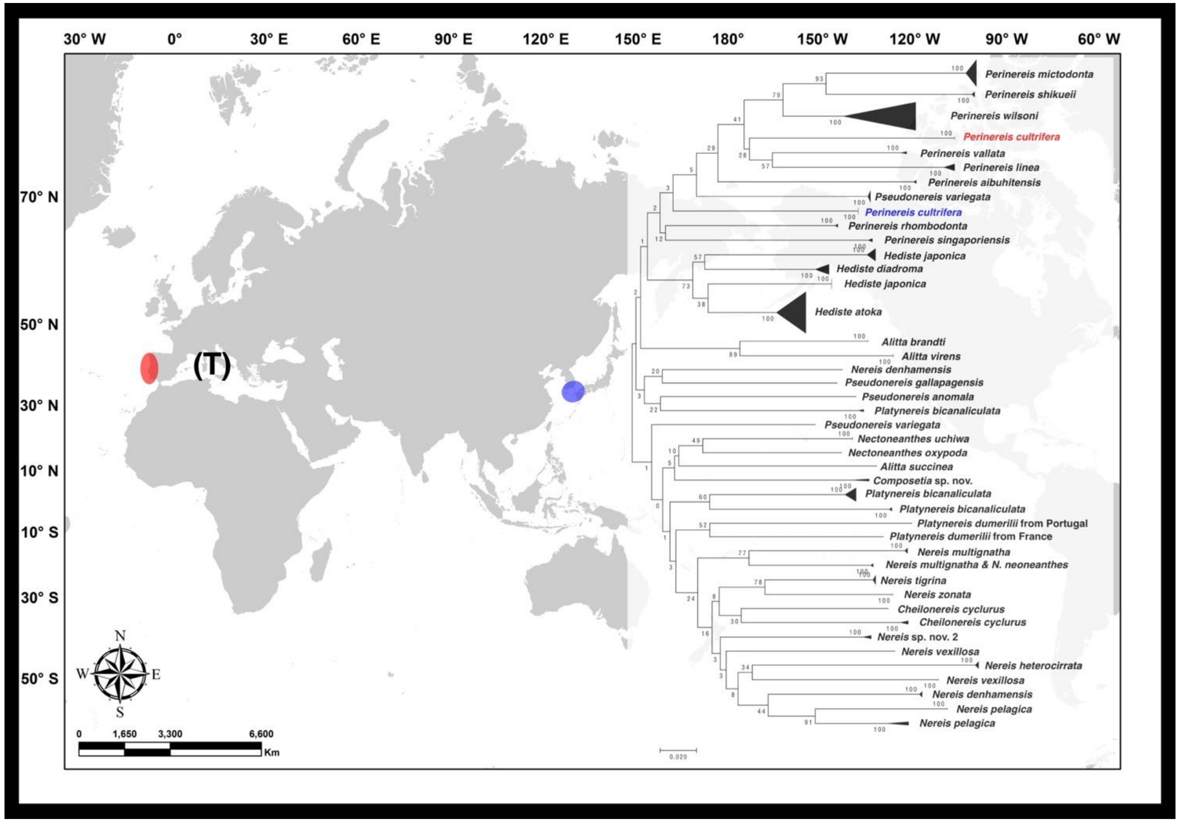

Fig. 8. Geographical difference of *Perinereis cultrifera* (Grube, 1840) specimens used in molecular taxonomic study. Red and blue shaded regions correspond to clade color on the neighbor joining tree. (T): Type locality of *P. cultrifera* (Grube, 1840).

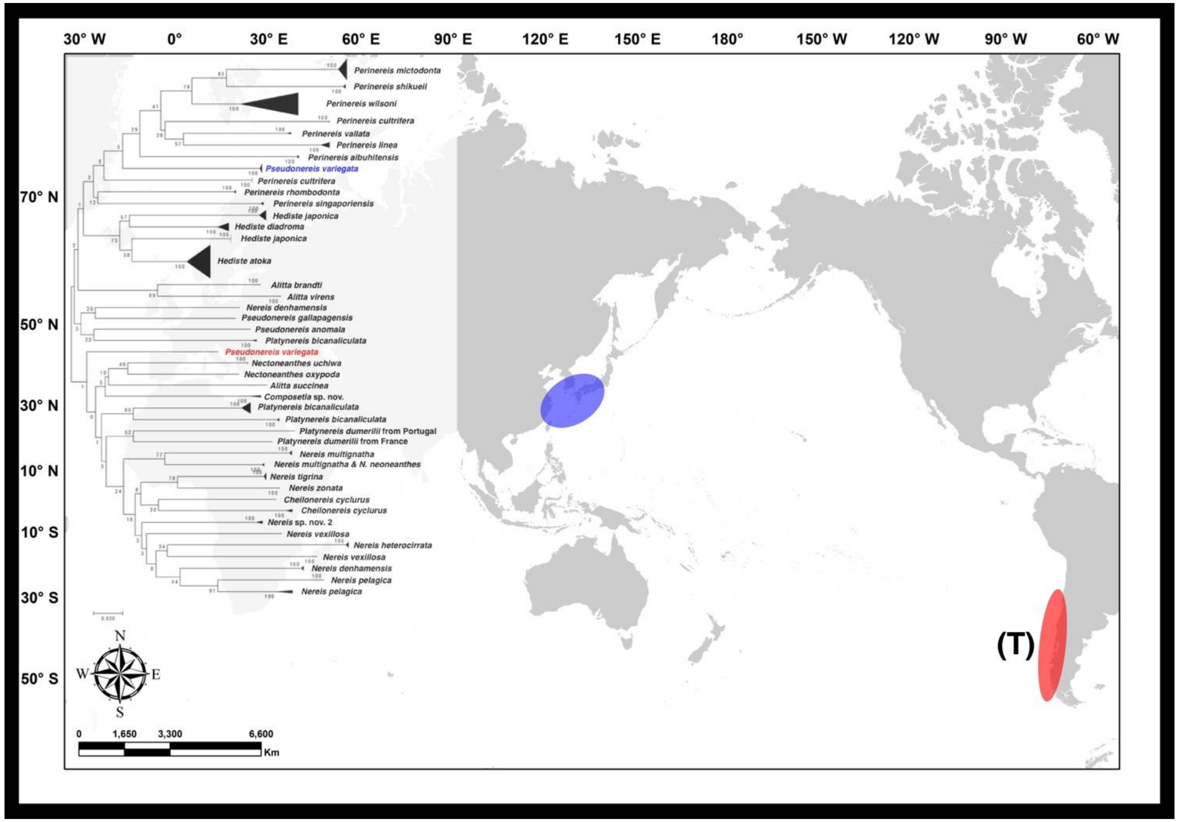

Fig. 9. Geographical difference of *Pseudonereis variegata* (Grube, 1857) specimens used in molecular taxonomic study. Red and blue shaded regions correspond to clade color on the neighbor joining tree. (T): Type locality of *P. variegata* (Grube, 1857).

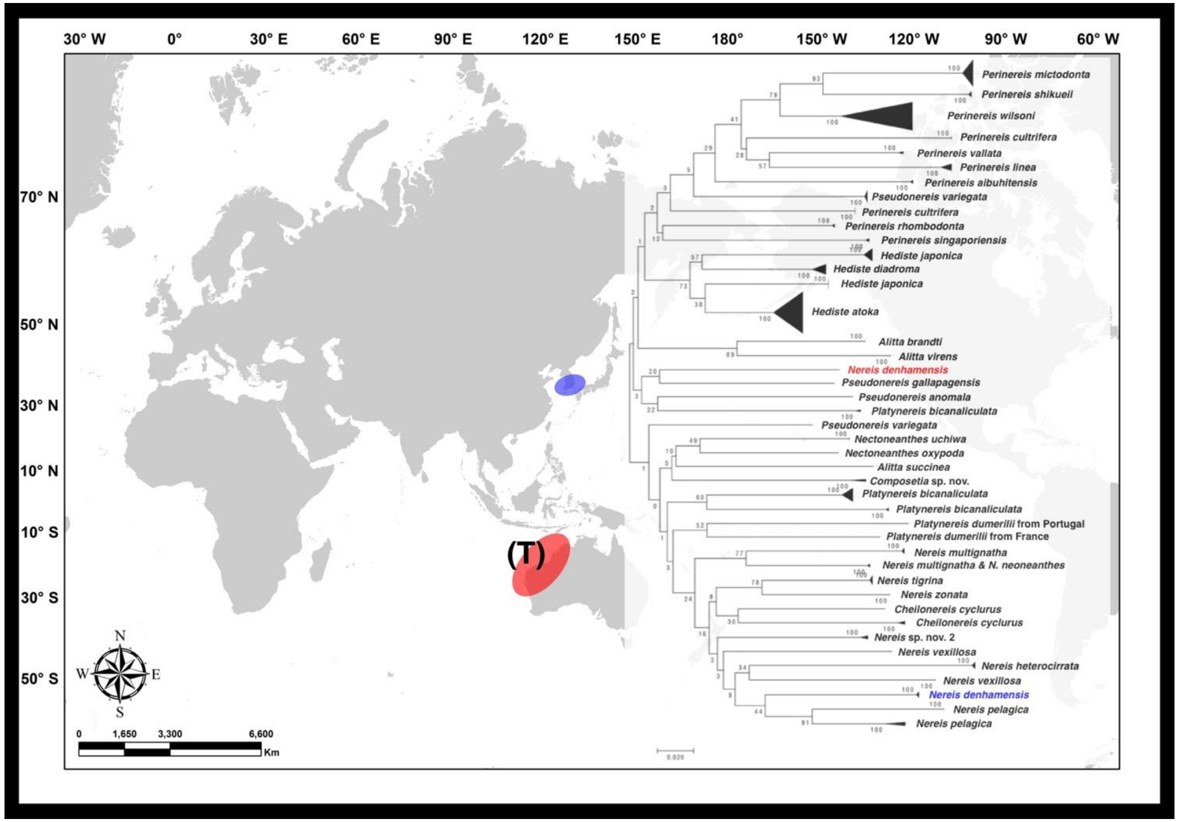

Fig. 10. Geographical difference of *Nereis denhamensis* Augener, 1913 specimens used in molecular taxonomic study. Red and blue shaded regions correspond to clade color on the neighbor joining tree. (T): Type locality of *N. denhamensis* Augener, 1913.

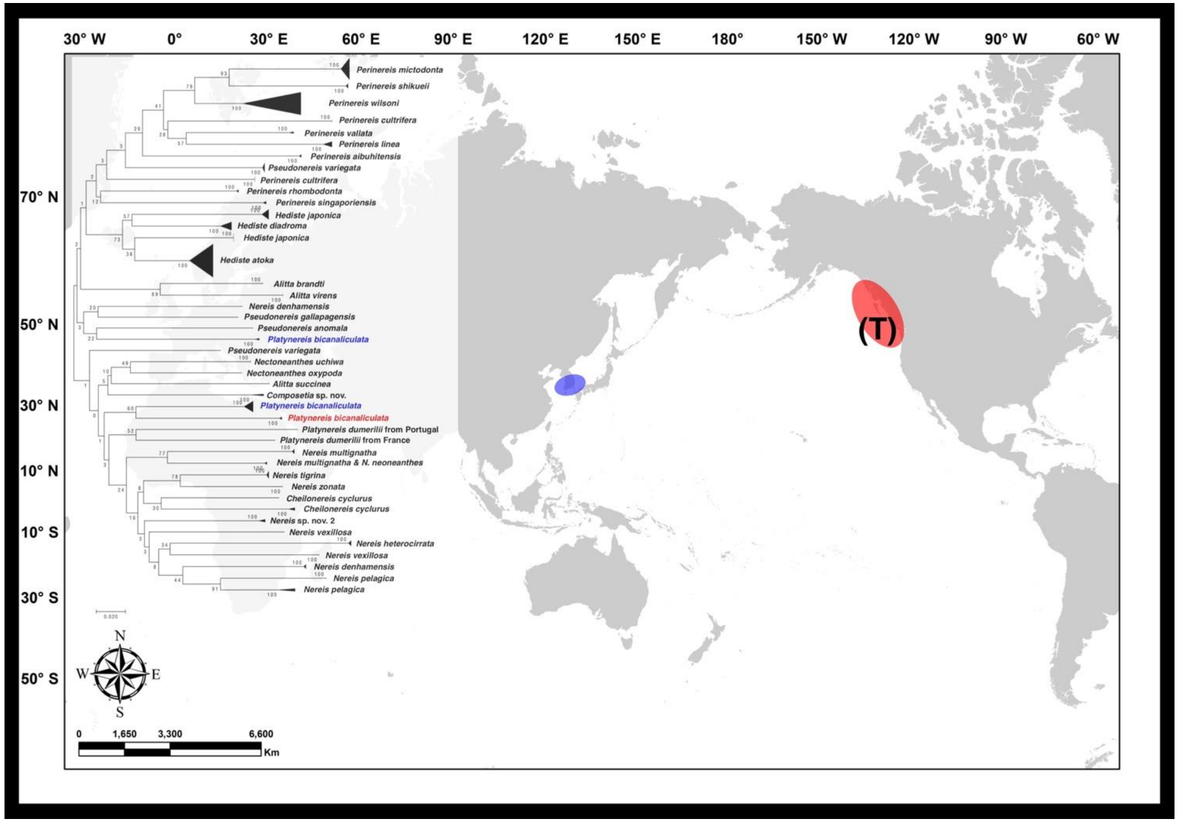

Fig. 11. Geographical difference of *Platynereis bicanaliculata* (Baird, 1863) specimens used in molecular taxonomic study. Red and blue shaded regions correspond to clade color on the neighbor joining tree. (T): Type locality of *P. bicanaliculata* (Baird, 1863).

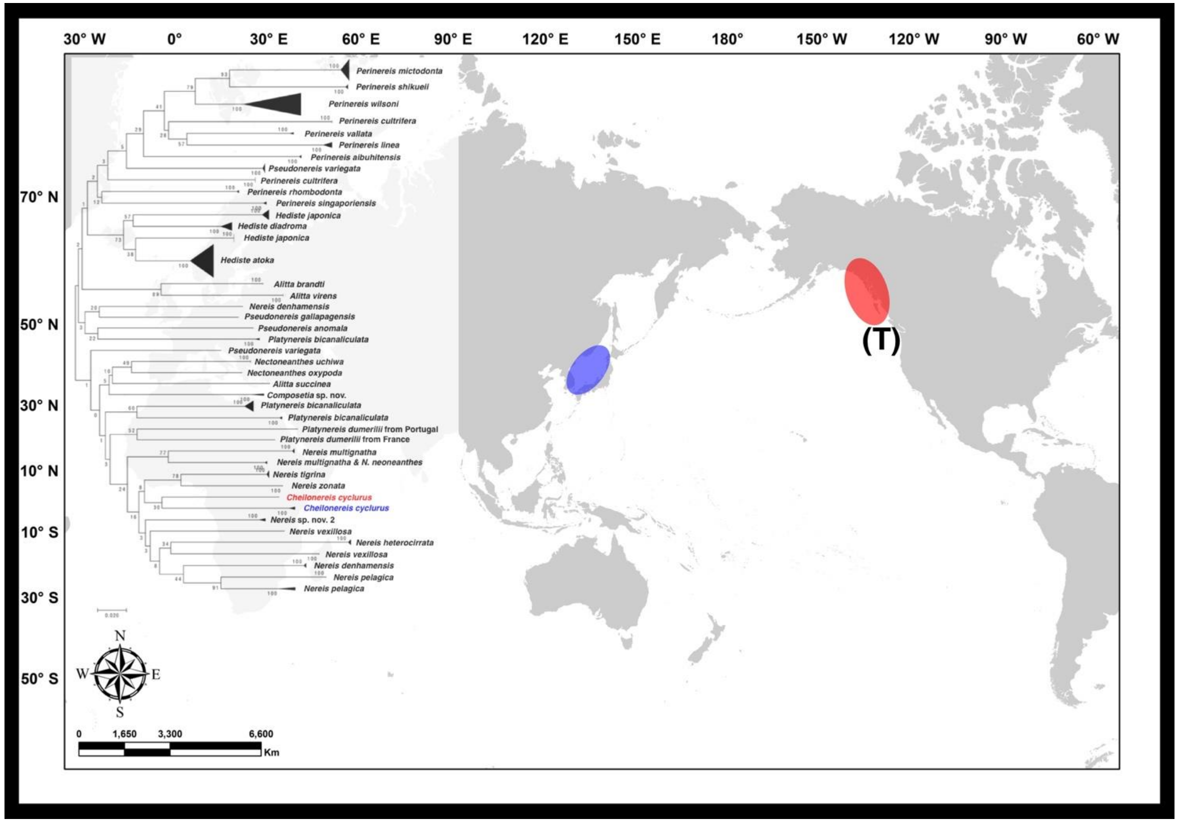

Fig. 12. Geographical difference of *Cheilonereis cyclurus* (Harrington, 1897) specimens used in molecular taxonomic study. Red and blue shaded regions correspond to clade color on the neighbor joining tree. (T): Type locality of *C. cyclurus* (Harrington, 1897).

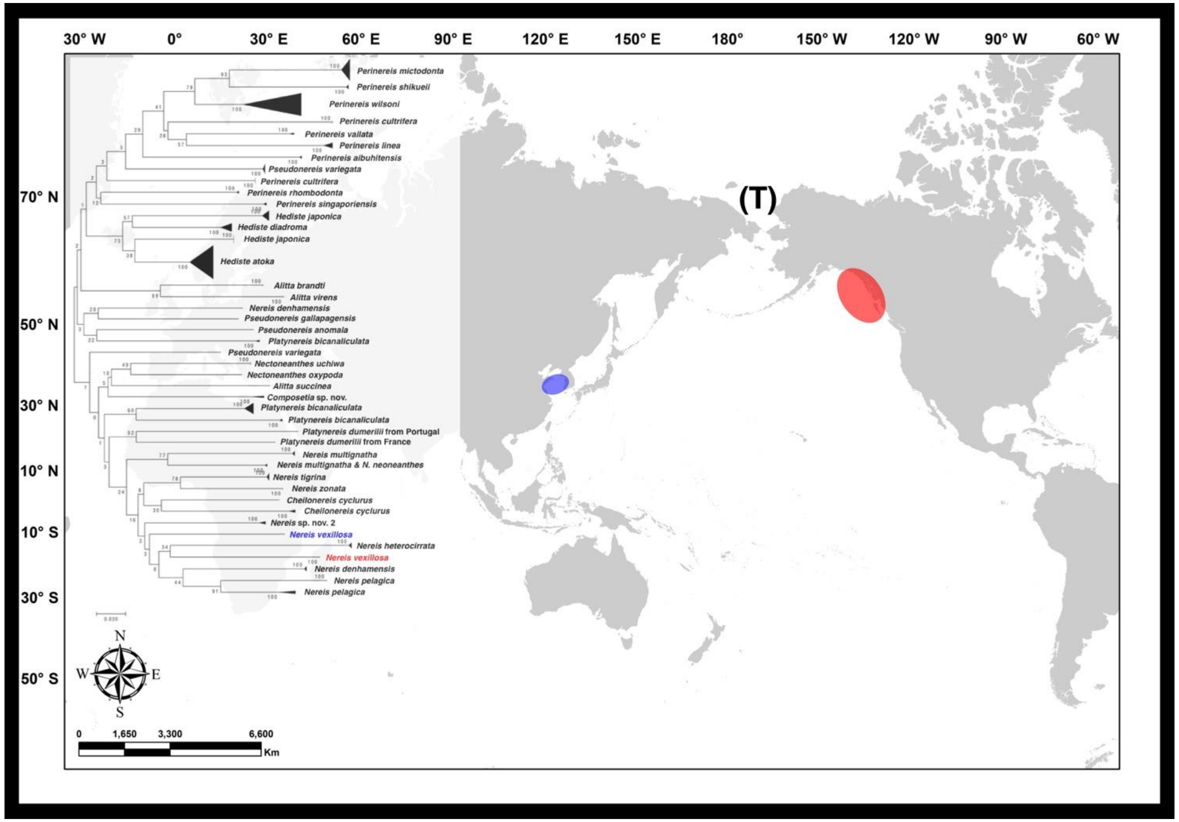

Fig. 13. Geographical difference of *Nereis vexillosa* Grube, 1851 specimens used in molecular taxonomic study. Red and blue shaded regions correspond to clade color on the neighbor joining tree. (T): Type locality of *N. vexillosa* Grube, 1851.

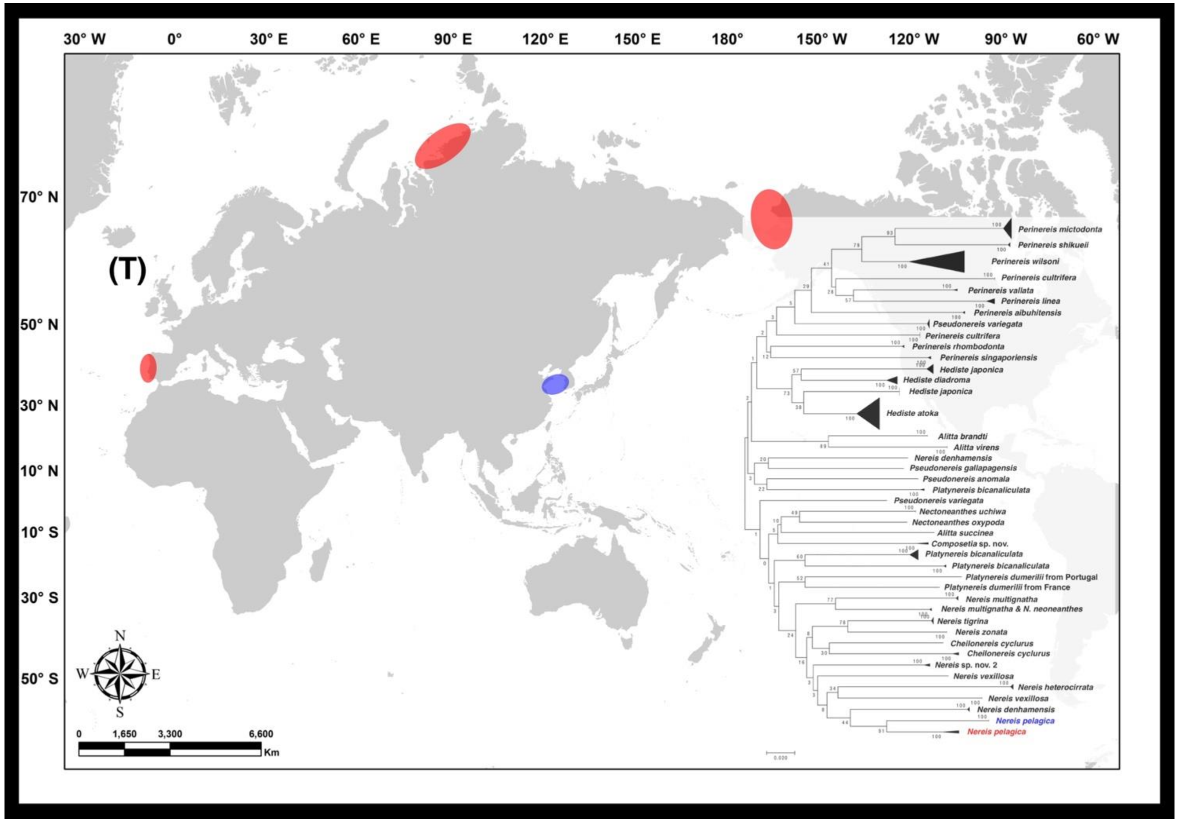

Fig. 14. Geographical difference of *Nereis pelagica* Linnaeus, 1758 specimens used in molecular taxonomic study. Red and blue shaded regions correspond to clade color on the neighbor joining tree. (T): Type locality of *N. pelagica* Linnaeus, 1758.

1.4. Discussion

The present molecular taxonomic analysis demonstrated the presence of provisional undescribed species or misidentified species among previously recognized nereidid species in Northeast Asia. Of these, three species (i.e., *Perinereis wilsoni*, *Hediste japonica*, and *N. multignatha*) were originally described from Northeast Asia. Each species might be composed of at least two cryptic species. Seven species (i.e., *Perinereis cultrifera*, *Pseudonereis variegata*, *Platynereis bicanaliculata*, *Cheilonereis cyclurus*, *Nereis denhamensis*, *N. vexillosa*, and *N. pelagica*) were originally described from areas outside Northeast Asia (Figs. 8–14). These Northeast Asian specimens previously identified as seven species described above are likely to be misidentified. Northeast Asian specimens of *Nereis neoneanthes* (type locality: Alaska) and *N. multignatha* are represented by single clade (clade M) in NJ tree (Fig. 7). This shows that *N. neoneanthes* from Northeast Asia might have been misidentified.

As discussed by Markmann and Tautz (2005), reverse taxonomic approach (i.e., initial investigation of the diversity of organism groups through DNA-based approach only) has been introduced for cases where taxon diversity can be hardly detected with conventional taxonomic approaches. Results of the present study showed that it might be fruitful to apply such approach for taxonomically ambiguous nereidid species.

Taxonomic treatment for newly detected taxa of this chapter is discussed in Chapter 2: Taxonomic Revision of Selected Northeast Asian Nereidids.

CHAPTER 2.

Taxonomic Revision of Selected Northeast Asian Nereidids

2.1. Introduction

Previous polychaetologists such as Olga Hartman, Marian Pettibone, and Pierre Fauvel have made relevant contributions to taxonomic study of the polychaete from many regions of the world. However, they mentioned that polychaete species were widespread or even cosmopolitan (see Fauvel 1925, 1932; Hartman, 1956; Salazar-Vallejo et al., 2014). Their idea and publications have influenced later researchers to neglect comparing type specimens and original descriptions when identifying and reporting local species (Fauchald, 1989; Salazar-Vallejo et al., 2014). The earliest taxonomic record of Northeast Asian nereidid was made by Grube (1866) from Shanghai, China. After his work, many researchers have made notable contributions to taxonomy of nereidids in this area (Wu, 1967; Imajima, 1972; Paik, 1977; Wu et al., 1985). At present, 105 nominal nereidid species have been reported. Among these, 53 nominal species were originally described outside of Northeast Asian waters (Table 1).

Northeast Asian waters can be divided into three geographical area: i.e. Sino-Japanese, Oriental, and Kuril from marine biogeographic point of view (Toonen et al., 2016). Higher endemism of nereidid species are expected (see background part).

In this chapter, 27 taxonomically ambiguous nominal species (Table 2) are reexamined by comparison with type and non-type specimens or recent redescriptions. Additionally, DNA sequences of mitochondrial cytochrome c oxidase subunit I (COI) are compared among closely similar species. More than 10 provisional species were recognized from taxonomic reexamination using 'reverse taxonomic' approach for previously recorded 10 species (*Perinereis wilsoni* Glasby and Hsieh, 2006; *P. cultrifera* (Grube, 1840); *Pseudonereis variegata* (Grube, 1857); *Hediste japonica* (Izuka, 1908); *Nereis denhamensis* (Augener, 1913); *N. vexillosa* Grube, 1851; *N. pelagica* Linnaeus, 1758; *N. multignatha* Imajima and Hartman, 1964; *Platynereis bicanaliculata* (Baird, 1863); *Cheilonereis cyclurus* (Harrington, 1897)) in Chapter 1. Their taxonomic treatments are included here. Two unknown species were collected from Korean waters during fieldwork for the present study. They are identified as two new species. Their descriptions are also provided here.

As a result of this study, the list of nereidid species from Northeast Asia is newly compiled to have 80 valid species.

2.2. Specimen collection and morphological observation

Most specimens were collected from Korea, and some were collected from Japan and China during 2007 to 2017. Sampling methods were the same as described in 'Collection and sample processing' part in chapter 1. Comparative specimens were borrowed from Museum für Naturkunde, Berlin, Germany (ZMB), National Museum of Natural History, Washington DC, USA (USNM), National Museum of Nature and Science, Tsukuba, Japan (NSMT), Natural History Museum University of Oslo, Norway (NHMO), and Zoological Museum, University of Copenhagen, Denmark or collected from Cambodia (Koh Rung Samloem Island), Australia (Darwin, Northern Territory), and Palau (Melekeok) (Table 7). Some specimens from Japan were kindly donated by Prof. Masanori Sato from Kagoshima University. Newly collected specimens (including molecular study vouchers) are housed at the National Institute of Biological Resources, Incheon, Korea.

Paragnaths on the proboscis were counted for each area. Photographs were taken with a built-in digital camera attached to a stereoscopic microscope (Leica EZ4 HD) or with a Canon 5D Mark II (60 mm macro lens). Drawings were prepared with a camera lucida attached to a stereoscopic microscope (Nikon SMZ1500) or compound microscope (Nikon eclipse 80i). Image stacks were obtained using Helicon Focus (Mac OS X ver. 4.2.9 by d-studio) and post-processed using iPAD pro version of Adobe Illustrator Draw, Graphic, and Photos.

Terminologies of paragnaths followed those of Bakken et al. (2009). Parapodial and chaetal morphology is described according to Bakken and Wilson (2005).

Table 7. Comparative specimens for morphological comparison.

Nominal name	Type of specimen	Voucher No.	Specimen locality
Alitta brandti	Non-type	ZMB 3598a,	Japan
	Non-type	ZMB 3598b	Japan
	Non-type	ZMB 6735	California, USA
Nereis virens	Lectotype	NHMO C3435	Bergen area, Norway
Alitta virens	Non-type	NHMO C3429	Bergen area, Norway
Cheilonereis cyclurus	Non-type	NSMT-Pol-16921–16953	Matsukawa Bay, Japan
	Topotype	USNM 29050	Puget Sound, USA
Hediste atoka	Holotype	NSMT-Pol-H454	Japan
Hediste diadroma	Holotype	NSMT-Pol-H456	Japan
Nereis neoneanthes	Holotype	USNM 20918	Alaska, USA
Nereis vexillosa	Syntype	ZMB Q4069	Alaska, USA
	Syntype	ZMB Q4070	Sea of Okhotsk
	Syntype	ZMB Q4068	Alaska, and San Francisco
	Topotype	USNM 15802	Bering Sea, Alaska
	Non-type	NSMT-Pol-14130–14139	Hokkaido, Japan
Nereis cultrifera	Syntype	ZMB 5653	Naples, Italy
Pereinereis anderssoni	Non-types	USNM24255	Sao Francisco, Brazil
Perinereis helleri	Non-types	NIBRIV000022065	St. Johns Is., Singapore
Perinereis cultrifera var. *floridana*	Non-type	NSMT-Pol-18672–18675	Japan
Nereis (*Perinereis*) *aibuhitensis*	Paralectotype	ZMB Q3440	Aibuhit, Palau
Perinereis aibuhitensis	Non-type (Topotype)	NIBRIV0000787926	Melekeok, Palau
	Non-type	NIBRIV0000787927	Koh Kong, Cambodia
Nereis (*Neanthes*) *linea*	Holotype	USNM 20115	Xiamen, China
Nereis (*Neanthes*) *orientalis*	Holotype	USNM 20116	Xiamen, China
Perinereis vancaurica tetradentata	Holotype	NSMT-Pol-H78	Tokyo, Japan

2.3. Taxonomic Accounts

Phylum Annelida

Class Polychaeta Grube, 1850

Subclass Errantia Audouin and H. Milne Edwards, 1832

Order Phyllodocida Dales, 1962

Suborder Nereidiformia Glasby, 1993

Superfamily Nereidoidea Blainville, 1818

Family Nereididae Blainville, 1818

Subfamily Nereidinae Blainville, 1818

Genus *Alitta* Kinberg, 1865

Alitta Kinberg, 1865: 172; Khlebovich, 1996: 108–109.

Type species: *Nereis virens* Sars, 1835.

Diagnosis

Prostomium with entire anterior margin, one pair of antennae, one pair of biarticulated palps with conical palpostyles, four pairs of tentacular cirri with distinct cirrophores. Two pairs of eyes. One apodous anterior segment, greater than length of chaetiger 1. Maxillary ring of pharynx, conical paragnaths: areas I–IV, present. Oral ring, conical paragnaths: area V, present or absent, VI–VIII, present. Notopodial dorsal ligule may be markedly elongate, broader on posterior chaetigers. Notopodial prechaetal lobe present throughout. Neuropodial postchaetal lobe digitiform, projecting beyond end of acicular ligule, present throughout all chaetigers. Notoaciculae absent from chaetigers 1 and 2. Notochaetae: homogomph spinigers. Upper neurochaetae: homogomph spinigers; heterogomph falcigers on anterior chaetigers present, on posterior chaetigers present or absent. Lower neurochaetae: heterogomph spinigers and falcigers present. (modified from Bakken and Wilson, 2005).

1. *Alitta* cf. *brandti* Malmgren, 1865 (Figs. 15–20)

Alitta brandti Malmgren, 1865: 183–184; Khlebovich, 1996: 113–114, taf. XXI.

Nereis dyamushi Izuka, 1912: 169–171, pl. 18, figs. 1–7.

Neanthes virens: Imajima and Hartman, 1964, 145–146; Imajima, 1972: 110–113, fig. 33; 1996: fig. 113a–i.

Materials examined

Non-type materials

ZMB3598a, 1 ind.; ZMB3598b, 1 ind., Japan, collected by Dybowsky, no further data. NIBRIV0000787925, 1 ind., male epitoke, Mukho Harbor, Mukhojin-dong, Donghae-si, Gangwon-do, Korea, 25 April 2016, collected by Kwang-Soo Kim and Hyung-Geun Kim by light trap, fixed in 80% ethanol.

Comparative materials

Lectotype of *Nereis virens* Sars, 1835 (NHMOC3435), Bergen area, Norway, 1916, 1 ind., no further data, designated by Tolkild Bakken, 2005. Non-type of *Alitta virens* (Sars, 1835), (NHMOC3429), Bergen area, Norway, 1916, 4 inds, no further data. Non-type of *Alitta brandti* Malmgren 1865, (ZMB6735), California, USA, 1 ind., no further data. Non-type of *Nereis virens* Sars, 1835, Gloucester, Massachusetts, USA, 1 ind., 1878, no further data.

Diagnosis

Dark brown colored dorsum in live specimens. Conical paragnath present on both maxillary and oral ring. Noropodial prechaetal lobe and neuropodial postchaetal lobe present throughout. Notopodial dorsal ligule greatly expanded posteriorly.

Description of atoke and epitoke

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with deep longitudinal midventral groove. Dorsum dark brown color in live individuals, pale cream color in preserved ones.

Prostomium pyriform, wider than long, with pair of thick, tapered antennae inserted at anterior end. Pair of palps with massive palpophores and shorter rounded palpostyles. Two pairs of eyes arranged trapezoidally; anterior pair slightly larger than posterior pair; gap of anterior pair slightly wider than posterior pair (Figs. 15A, 16A, 17A).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 5–6 (Figs. 15A, 17A).

Proboscis with pair of dark brown amber jaws, each with 5–6 teeth of serrated inner margin (Figs. 15B, 17B). Paragnaths present on both maxillary and oral rings. Paragnath numbers and arrangements as follows: area I, 3–4; area II, 7–13 on left, 7–10 on right, in irregular cluster; area III, 15–16 in irregular cluster with lateral groups; area IV, 27–30 on left, 29–31 on right, arranged in curved cluster; area V, 1–5; area VI, 1–6 on left, 3–5 on right; areas VII–VIII, 40–96 paragnaths arranged 4–5 rows of conical paragnaths (Table 8) (Figs. 2B, C; 16A, B; 17A, B). Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus (Fig. 17C).

Notopodia consisting of dorsal cirrus, dorsal ligule, prechaetal lobe, and ventral ligule in biramous parapodia (Figs. 15D–F; 17D–E; 18A–F). Dorsal cirri slender, slightly shorter than (or same in length as) notopodial ventral ligule in anterior and middle parapodia, slightly longer than notopodial ventral ligule in posterior parapodia (Figs. 15D–F; 17D–E; 18A–F). Notopodial dorsal ligule subtrinagular throughout, gradually expanding posteriorly (Fig. 18A–D). Notopodial prechaetal lobe distinctive throughout, shorter than notopodial dorsal and ventral ligules. Notopodial ventral ligule, approximately subequal toneuropodial ventral ligule, subconical with tapering tip throughout (Figs. 17D–E, 18A–F).

Neuropodia consisting of acicular ligule, postchaetal lobe, ventral ligule, and ventral cirrus throughout. Neuropodial postchaetal lobe subconical projecting beyond end of acicular ligule in anterior parapodia, same in length to acicular ligule middle and posterior parapodia. Neuropodial ventral ligule digitate, reduced in size posteriorly. Ventral cirri slender, shorter than ventral ligules throughout (Figs. 15E–F, 17D–E, 18A–F).

Notochaetae all homogomph spinigers; blades long with finely serrated edge (Fig. 15G, 17F). Upper neurochaetae consisting of homogomph spinigers with long serrated blades and heterogomph long falcigers with serrated blades in anterior parpapodia (Fig. 15H, 17I); homogomph spinigers only in posterior parapodia. Lower neurochaetae consisting of homogomph and heterogomph spinigers with long serrated blades and heterogomph long falcigers with serrated blades in anterior parapodia; heterogomph spinigers (Fig. H) only in posterior parapodia.

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

In epitokous stage, notopodial dorsal and ventral ligules expanded in middle and posterior parapodia, neuropodial postchaetal lobes well developed in middle parapodia.

Heterogomph falcigers absent throughout, epitoke-specific sesquigomph spinigers present in both noto and neurochaetae (Fig. 17G).

Variation in paragnath number

Paragnath numbers are summarized in Table 8.

Habitats

Shallow muddy or sandy subtidal zones.

Distribution

Type locality: East Siberian Sea. Northeast Asia (Korea and Japan) (Fig. 19).

Molecular data

The COI sequence obtained from one individual (Table 4, Appendix 2).

Remarks

Alitta brandti is very similar to *A. virens* (M. Sars, 1835) and *A. grandis* (Stimpson, 1853) in morphological characters, but different from them in reproduction and life history (Khlebovich, 1996). In Northeast Asian waters, Izuka (1912) has described *Nereis dyamushi* as a new species from Northern Japan, referring that *N. dyamushi* is very close to both *N. virens* and *N. brandti* but different from them in paragnath numbers and arrangement. Later, Imajima and Hartman (1964) have treated *N. dyamushi* as a junior synonym of *Neanthes virens* while Khlebovich (1996) has regarded previous records of *N. dyamushi* and *N. virens sensu* Imajima and Hartman (1964) as a junior synonym of *A. brandti*.

The present specimens are similar to *A. brandti* by having more paragnaths in area II, IV, V, VI, and VII–VII (Table 9) than *A. virens* (Fig. 16). Comparison of DNA sequences of COI between the present specimen (from Korea) and *A. virens* (from Atlantic Ocean) showed marked differences between the two (mean p-distance: 0.155) (Fig. 20, Table 10). As suggested by Khlebovich (1996), further studies comparing reproductive and molecular characters of all three species are needed to confirm the taxonomic status of *A.* cf. *brandti* from Northeastern Asian waters.

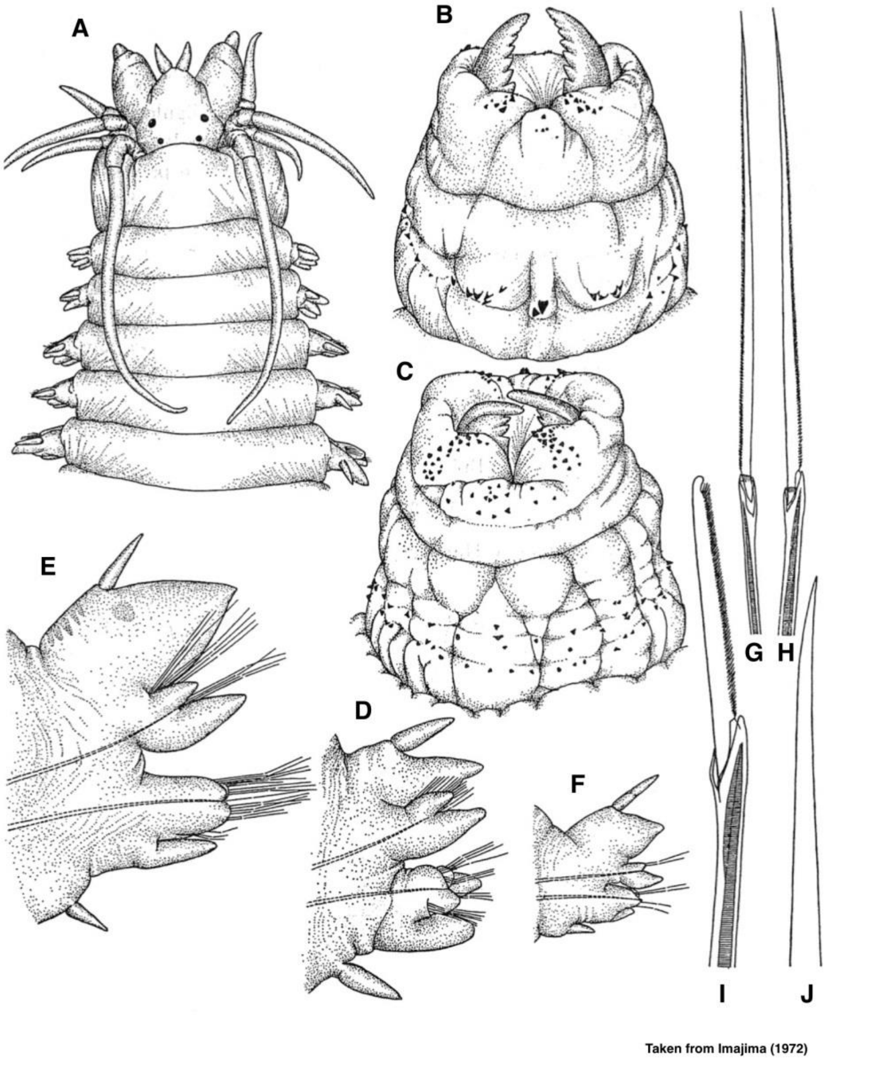

Fig. 15. *Alitta* cf. *brandti* Malmgren, 1865, atoke, (A) Dorsal view of anterior end. (B, C) Dorsal and ventral views of anterior end with everted proboscis. (D) Anterior view of parapodium 5. (E) Anterior view of middle parapodium. (F) Anterior view of posterior parapodium. (G) Homogomph spiniger from notopodial fascicle in anterior parapodium. (H) Heterogomph spiniger from neuropodial lower fascicle in anterior parapodium. (I) Heterogomph falciger from neuropodial lower fascicle. (J) Aciculum from middle parapodium. Magnification: 5× in (A); 11× in (B, C); 22× in (D–F); 220× in (G, H); 410× in (I); 73× in (J). Taken from Imajima (1972) as *Neanthes virens*.

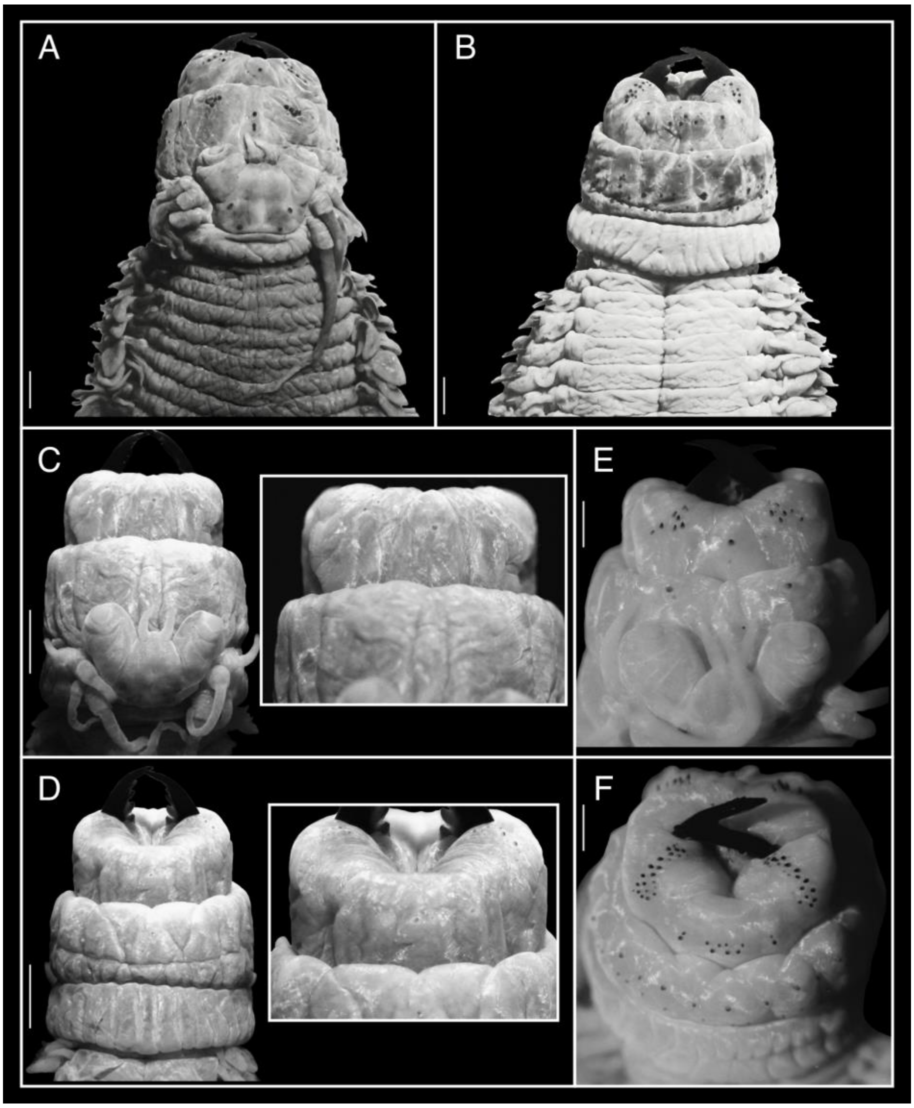

Fig. 16. Dorsal and ventral views of everted proboscis of two *Alitta* species. (A, B) *A.* cf. *brandti* Malmgren, 1865 (NIBRIV0000787925). (C, D) *A. virens* (M. Sars, 1835) (lectotype, NHMOC3435). (E, F) *A. virens* (M. Sars, 1835) (USNM22).

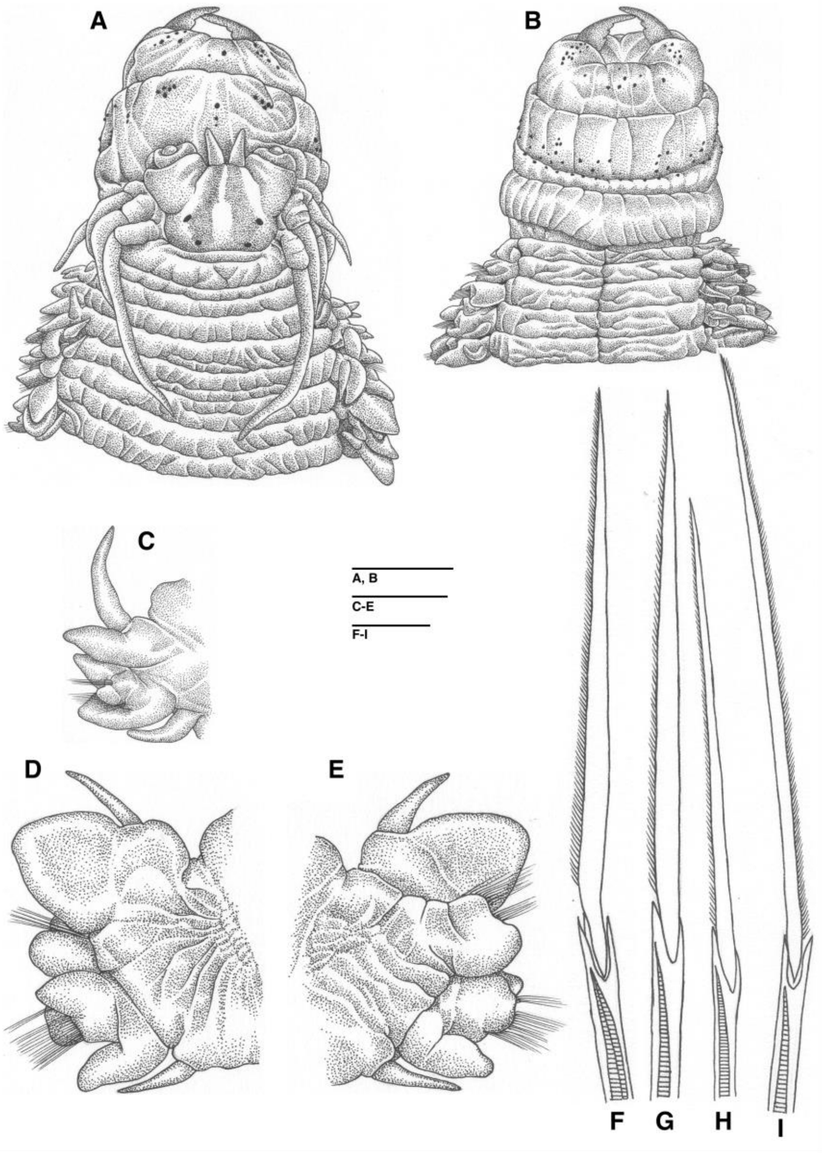

Fig. 17. *Alitta* cf. *brandti* Malmgren, 1865, epitoke. NIBRIV0000787925. (A, B) Dorsal and ventral views of anterior end with everted proboscis. (C) Anterior view of parapodium 1. (D) Posterior view of parapodium 10. (E) Anterior view of parapodium 10. (F) Homogomph spiniger from notochaetae in parapodium 104. (G) Epitokous specific sesquigomph spiniger from upper neurochaetae in parapodium 104. (H) Heterogomph spiniger from lower neurochaetae in parapodium 104. (I) Homogomph spiniger from upper neurochaetae in parapodium 104. Scale bars: 5 mm in (A, B); 2 mm in (C–E); 0.02 mm in (F–I).

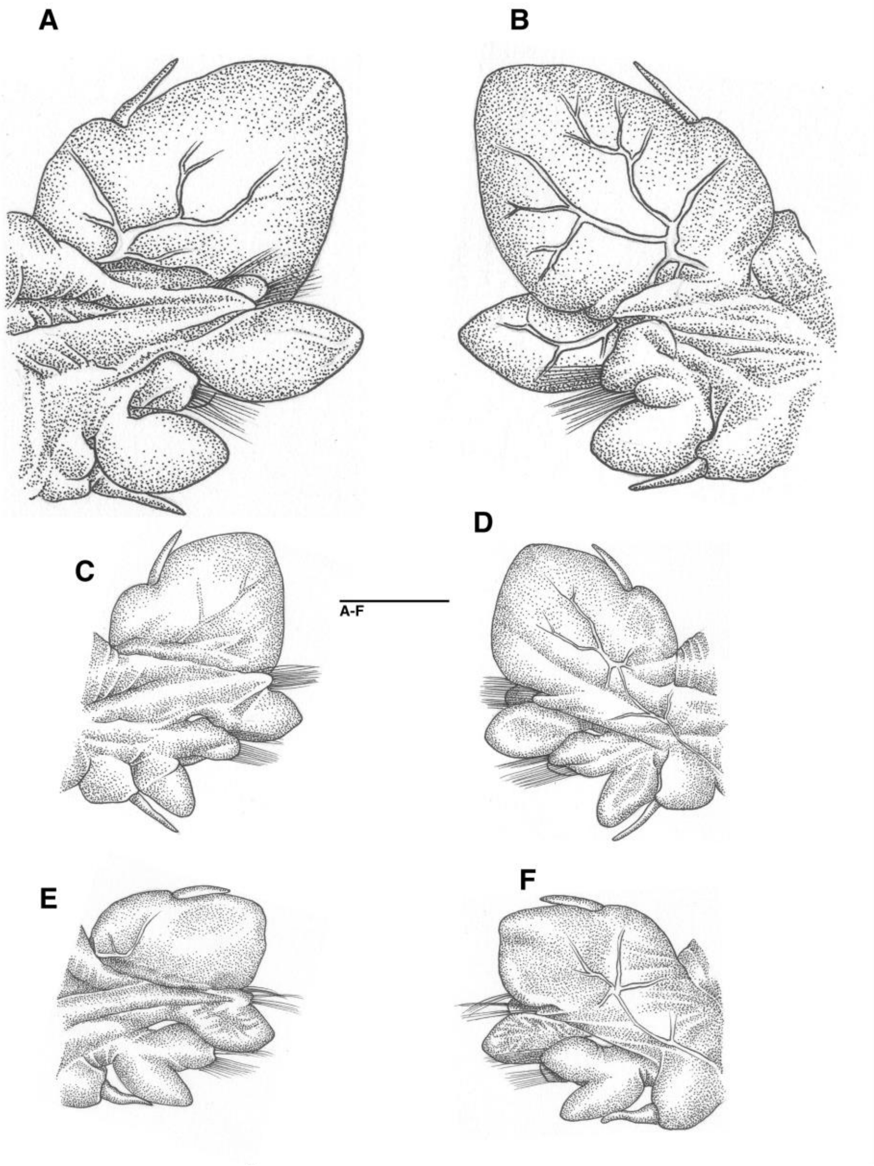

Fig. 18. Parapodia of *Alitta* cf. *brandti* Malmgren, 1865, epitoke. NIBRIV0000787925. (A, B) Anterior and posterior views of parapodium 72. (C, D) Anterior and posterior views of parapodium 159. (E, F) Anterior and posterior views of parapodium 196. Scale bar: 3 mm in (A–F).

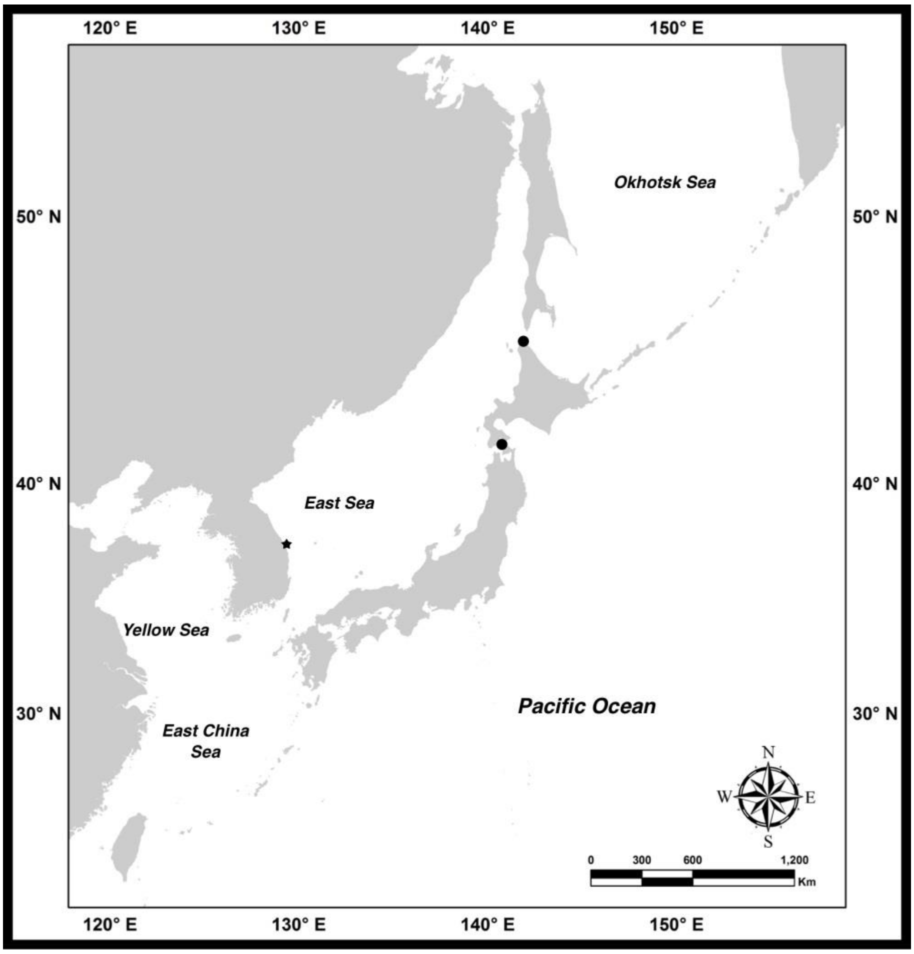

Fig. 19. Distribution of *Alitta* cf. *brandti* Malmgren, 1865 in Northeast Asia based on the present study (★) and the literature. (●) Imajima, 1972.

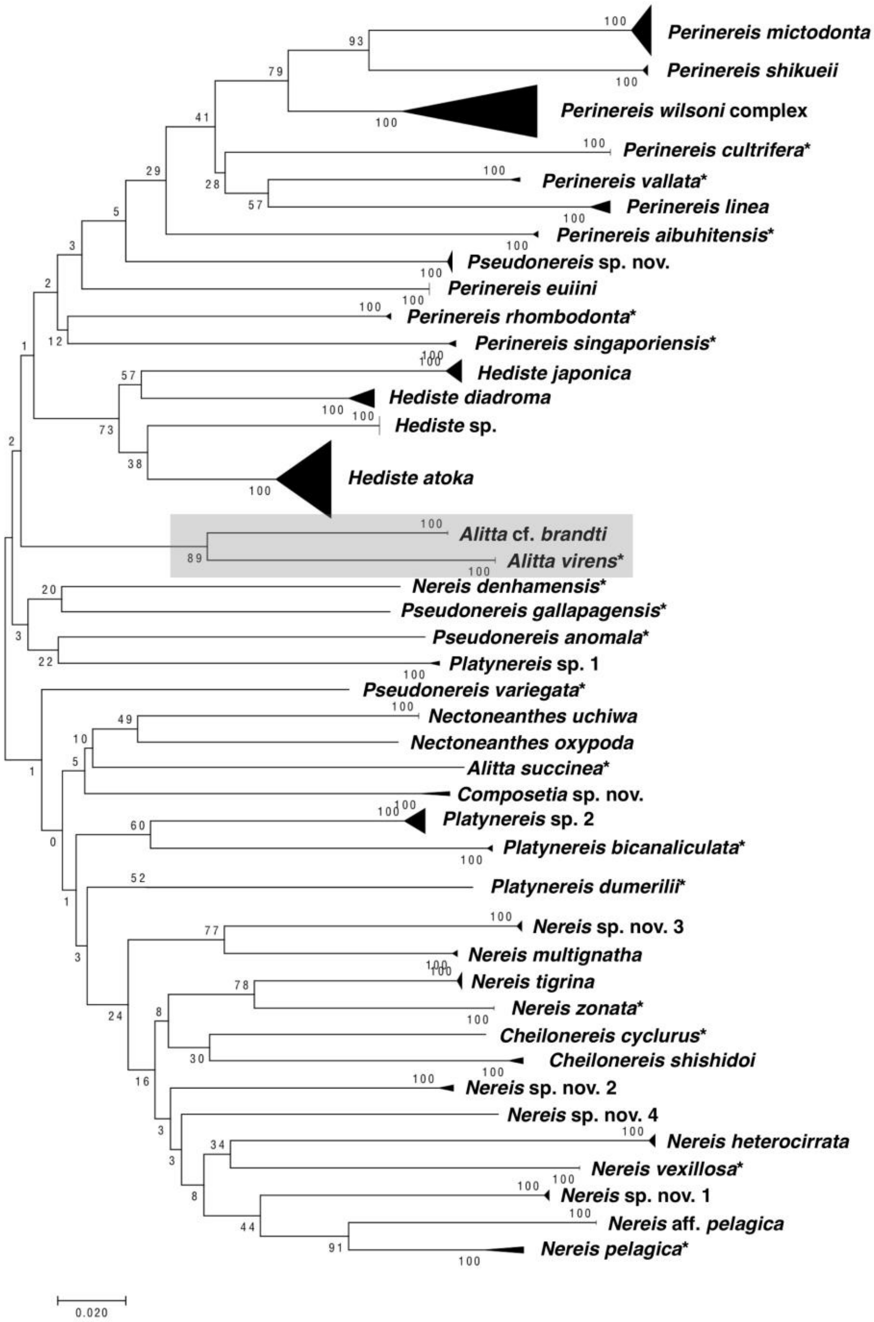

Fig. 20. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray box represents the difference between *Alitta* cf. *brandti* Malmgren, 1865 and *A. virens* (M. Sars, 1835).

Table 8. Variation in paragnath numbers in area I to VI on proboscis of *Alitta* cf. *brandti* Malmgren, 1865. Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Locality	**I**	**II(L)**	**II(R)**	**III**	**IV(L)**	**IV(R)**	**V**	**VI(L)**	**VI(R)**	**VII–VIII**
Korea (n=1) (Present study)	4	13	10	16	29	31	5	6	5	96
Japan (n=2) (Present study)	3	7–9 (8±1.4)	7–9 (8±1.4)	15–16 (15.5±0.7)	27–30 (28.5±2.1)	29–31 (30±1.4)	1–3 (2±1.4)	1–4 (2.5±2.1)	3	40–58 (49±12.7)
Japan (n=?) (Izuka, 1912 as *Nereis dyamusi*)	4–5	irregular curved row		many transverse rows	irregular curved row		2–3	small irregular mass		irregular transverse row
Japan (n=?) (Imajima, 1972 as *Neanthes virens*)	4–5	9–10		15–17	26–30		1–3	3–5		three irregular transverse band

Table 9. Comparison of key characteristics of *Alitta brandti* Malmgren, 1865 and *A. virens* (M. Sars, 1835).

Species (Locality and reference)	**Range of paragnath number**							
	I	**II***	**III (total)**	**III* (lateral)**	**IV***	**V**	**VI***	**VII–VII**
A. cf. *brandti* (Korea, present study, 1 non-type)	4	10–13	16	1–2	29–31	5	5–6	96
A. cf. *brandti* (Japan, present study, 2 non-types)	3	7–9	15–16	1–4	27–31	1–3	1–4	40–58
A. brandti (California, present study, 1 non-type)	2	9–11	9	16	27–31	2	4–5	59
(Russia, Khlebovich, 1996)	2–6	8–20	15–25	?	30–50	1–2	3–7	60–80
A. virens (Norway, present study 1 lectotype)	1	2–3	6	1	9–11	0	1	?
(Russia, Khlebovich, 1996)	1	5–8	7–11	?	13–18	0	1	15–25

*Paragnath numbers on each side.

Table 10. Mean pairwise genetic distances (K2P distance) based on COI sequences between *Alitta* cf. *brandti* Malmgren, 1865 and *A. virens* (M. Sars, 1835). n = number of individuals.

Species	*A.* cf. *brandti*	*A. virens*
A. cf. *brandti* (n=1)	0	0.155
A. virens (n=3)	0.155	0

Genus *Cheilonereis* Benham, 1916

Cheilonereis Benham, 1916: 138

Type species: *Nereis cyclurus* Harrington, 1897

Diagnosis

Ventral peristomial flap present, covering areas VII−VIII when proboscis everted. Conical paragnaths present on both maxillary and oral ring except area V. Dorsal notopodial ligule markedly elongate, broader on posterior chaetigers. Notopodial prechaetal lobe present, smaller than dorsal notopodial ligule on anterior chaetigers, restricted to a limited number of anterior chaetigers. Dorsal cirrus mid-dorsally to subterminally attached to notopodial dorsal ligule on posterior chaetigers, lacking basal cirrophore. Neuropodial postchaetal lobe absent or present. Notoaciculae absent from chaetigers 1 and 2. Notochaetae: homogomph spinigers and falcigers. Upper neurochaetae: homogomph spinigers, heterogomph falcigers, blades serrated. Lower neurochaetae: heterogomph spinigers, heterogomph falcigers with long blades on anterior chaetigers, medium blades on posterior chaetigers (modified from Bakken and Wilson, 2005).

2. *Cheilonereis shishidoi* (Izuka, 1912), reinst., n. comb. (Figs. 21–26)

Nereis shishidoi Izuka, 1912: 177–178, pl. 19, figs. 10–18.

Cheilonereis cyclurus: Okuda, 1950, 52–53; Uschakov, 1955: 213–214, fig. 67A–E; Imajima and Hartman, 1964: 142; Uschakov and Wu, 1965: 201; Imajima, 1972: 50–53, figs. 6, 7; 1996: 112, fig. 89; Paik, 1977: 26–28, fig. 9A–G; 1982: 784, pl. 11d–f; 1989: 293–295, pls. 20, 21, fig. 54a (1–4), text fig. 64A–H; Wu et. al., 1985: 79–80, fig. 43A–J; Park et. al., 2017: 669–672, fig. 1A–B.

Materials examined

Non-type materials

NIBRIV0000781322, 1 ind.; NIBRIV0000781323, 1 ind.; NIBRIV0000781324, 1 ind.; NIBRIV0000787920, 1 ind., commensal with hermit crab, subtidal zone (>150 m), Gajin Harbor, Gajin-ri, Jugwang-myeon, Goseong-gun, Gangwon-do, Korea, 17 March 2016, collected by Taeseo Park from local fishermen's gill net, fixed in 10% formalin. NIBRIV0000787922, 4 inds.; NIBRIV0000787932, 1 ind.; NIBRIV0000787933, 1 ind.; NIBRIV0000787934, 1 ind., commensal with hermit crab, subtidal zone (>150 m), Gajin Harbor, Gajin-ri, Jugwang-myeon, Goseong-gun, Gangwon-do, Korea, 17 March 2016, collected by Taeseo Park from local fishermen's gill net, fixed in 80% ethanol.

Topotypes

NSMT-Pol. 16921–16953, 5 inds. of many, identified as *Cheilonereis cyclurus*, Matsukawa Bay, Fukushima Prefecture, Japan, 11–13 July 1970, collected by Minoru Imajima, no further data.

Comparative materials

Topotypes of *Cheilonereis cyclurus* (Harrington, 1897) (USNM 29050), commensal with hermit crab, Puget Sound, San Juan Is., Brown Is., Washington, USA, 11 July 1936, 1 ind., collected by M. H. Pettibone, identified by M. H. Pettibone; (USNM 29056), Puget Sound, San Juan Is., John's Is., Washington, USA, 6 July 1939, 1 ind., collected by M. H. Pettibone, identified by M. H. Pettibone; (USNM 29065), commensal with hermit crabs, Puget Sound, San Juan Is., Washington, USA, 7 inds., collector unknown, identified by M. H. Pettibone.

Description of atokes

Body stout anteriorly, gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum with pinkish brown on anteriorly and dark greenish pigmentation posteriorly with transverse white stripe on oral side at each chaetigers throughout (Fig. 21).

Prostomium pyriform, longer than wide, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with large palpophores and subconical palpostyles. Two pairs of eyes arranged trapezoidally; anterior pair slightly smaller than posterior pair; gap of anterior pair wider than posterior pair. Pinkish brown pigmentation present on half of dorsal surface on oral side of prostomium (Figs. 22A, 24A).

Peristomium with pinkish brown pigment, longer than other chaetigers, with four pairs of tentacular cirri (Figs. 21, 22A); posterior dorsal tentacular cirri longest, reaching back to chaetiger 5–7 (Fig. 22A); ventral peristomial flap present covering areas VII–VIII (Fig. 23B, C).

Proboscis with pair of brown amber jaws, each with 9–10 teeth of serrated inner margin (Figs. 22A, B; 23A, 24A). Conical paragnaths present on both maxillary and oral rings except area V. Paragnath numbers and arrangements as follows: area I, 2–4 in longitudinal row; area II, 12–29 on left and 16–29 on right, arranged in triangular patch; area III,19–34 in irregular transverse band; area IV, 22–34on left and 26–36 on right in oblique cluster; area V, absent; area VI, 8–12 on left and 6–13 on right in circular cluster; area VII–VIII, single transverse band of large cones in maxillary side, 3 to 5 rows of minute paragnath present below large cones (> 200) (Table 11) (Figs. 22A, B; 23A–C; 24A, B).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia with notoacicula and with reduced notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus (Fig. 22C).

Notopodia consisting of dorsal cirrus, dorsal ligule, prechaetal lobe and ventral ligule in biramous parapodia. Notopodial dorsal ligule subconical with blunt tip in anterior parapodia, gradually expanded to large triangular with prominent ovoid lobe developing above dorsal cirrus in middle and posterior parapodia; notopodial dorsal ligule most expanded in middle parapodia, gradually reduced in size in posterior parapodia (Fig. 22D–G). Notopodial prechaetal lobe small, gradually reduced in size posteriorly, inconspicuous in posterior parapodium, first prechaetal lobe appearing from chaetiger 3. Notopodial ventral ligule slender, subconical, with tapering tip throughout. Dorsal cirri slender, tapering, longer than notopodial dorsal ligule in anterior parapodia, slightly shorter or subequal to tip of notopodial dorsal ligule in middle and posterior parapodia (Fig. 22D–G).

Neuropodia consisting of acicular ligule, postchaetal lobe, ventral ligule and ventral cirrus throughout. Superior and inferior lobes present in neuroacicular ligule, gradually reduced posteriorly. Neuropodial postchaetal lobe present through out, not projecting beyond end of acicular ligule (anterior side). Neuropodial ventral ligule subequal to neuroacicular ligule, slender, digitate with tapering tip. Ventral cirrus slender with tapering tip (Fig. 22D–G).

Notochaetae consisting of homogomph or sesquigomph spinigers with finely serrated long blades (Fig. 22L) and homogomph falcigers with rod like blades (Fig. 22H); homogomph or sesquigomph spinigers present throughout; homogomph falcigers present only at posterior parapodia. Upper neurochaetae consisting of homogomph or sesquigomph spinigers with serrated blades, and heterogomph falcigers with serrated and curved end blades throughout (Fig. 22J). Lower neurochaetae consisting of heterogomph spinigers with serrated blades and heterogomph falcigers with serrated and curved end blades (Fig. 22K, I). Number of chaetae reduced posteriorly.

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri (Fig. 21).

Variation in paragnath number

Paragnath numbers in *Cheilonereis shishidoi* are summarized in Table 11.

Habitats

Subtidal zone, commensal with hermit crabs.

Distribution

Type locality: Yuriage, Miyagi Prefecture. China (Yellow Sea), Korea (East Sea), Japan (northern Japan, Pacific Ocean), Russia (East Sea, Okhotsk Sea) (Fig. 25).

Molecular data

The COI sequences obtained from three individuals (Table 4, Appendix 2).

Remarks

Cheilonereis species is easily distinguishable from other nereidid species with unique characteristics of ventral peristomial flap at oral ring. There are two valid species in this genus: (1) *C. cyclurus* (Harrington, 1897) from Puget Sound, USA; and (2) *C. peristomialis* Benham, 1916 from New Zealand. In Northeast Asia, *Nereis shishidoi* from Japan was described as a new species by Izuka (1912). Later, this species was synonymized as *C. cyclurus* by Okuda (1950) for the following reasons: (1) structures of its head and feet are very similar to those of *C. cyclurus*, and (2) slight differences in the number of paragnaths are insufficient for specific distinction between *C. cyclurus* and *N. shishidoi* (Table 12).

In the present study, comparison of DNA sequences of COI between the present specimen (from east coast of Korea) and *C. cyclurus* (from Canada, Pacific Ocean) showed marked differences (mean p-distance: 0.173) (Fig. 26, Table 14). These two species are also morphologically distinguishable in newly found characteristics of chaetal arrangement. According to the original description of *C. cyclurus*, Harrington (1897) did not mention about the presence of notopodial homogomph falcigers. However, Bakken and Wilson (2005) described notopodial homogomph falcigers present from chaetigers 27 to 29 based on topotype materials. In the description of *N. shishidoi* Izuka, 1912 or *C. cyclurus sensu* Okuda (1950) and Imajima (1972), the presence of notopodial homogomph falcigers was not mentioned either. However, the present study confirmed the presence of notopodial homogomph falcigers but only from posterior chaetigers based on specimens collected from the east coast of Korea and around type locality of Japan (Table 13).

A set of polychaete specimens collected and studied by Izuka were discovered recently in The University Museum, The University of Tokyo, Japan (Nishi and Tanaka, 2011). However, there was no information for the type specimen of *N. shishidoi*. It might have been lost to the Great Kanto Earthquake of 1923 or bombing in Tokyo in the Second World War of 1945 (personal communication, Sato). Therefore, topotype specimens deposited in NSMT were examined to confirm the present taxonomic judgement for reinstatement of *C. shishidoi* (Izuka, 1912).

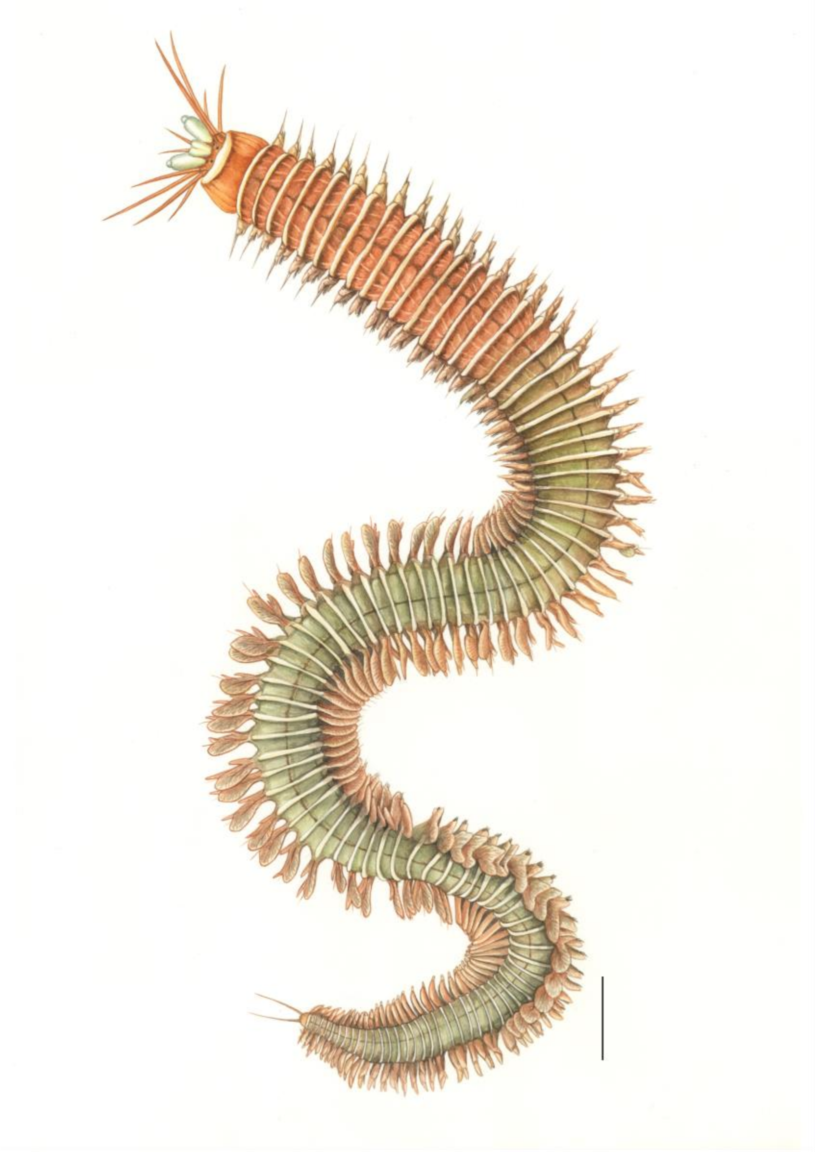

Fig. 21. Drawing of *Cheilonereis shishidoi* (Izuka, 1912) based on a non-type (NIBRIV0000781323). Scale bar, 10 mm.

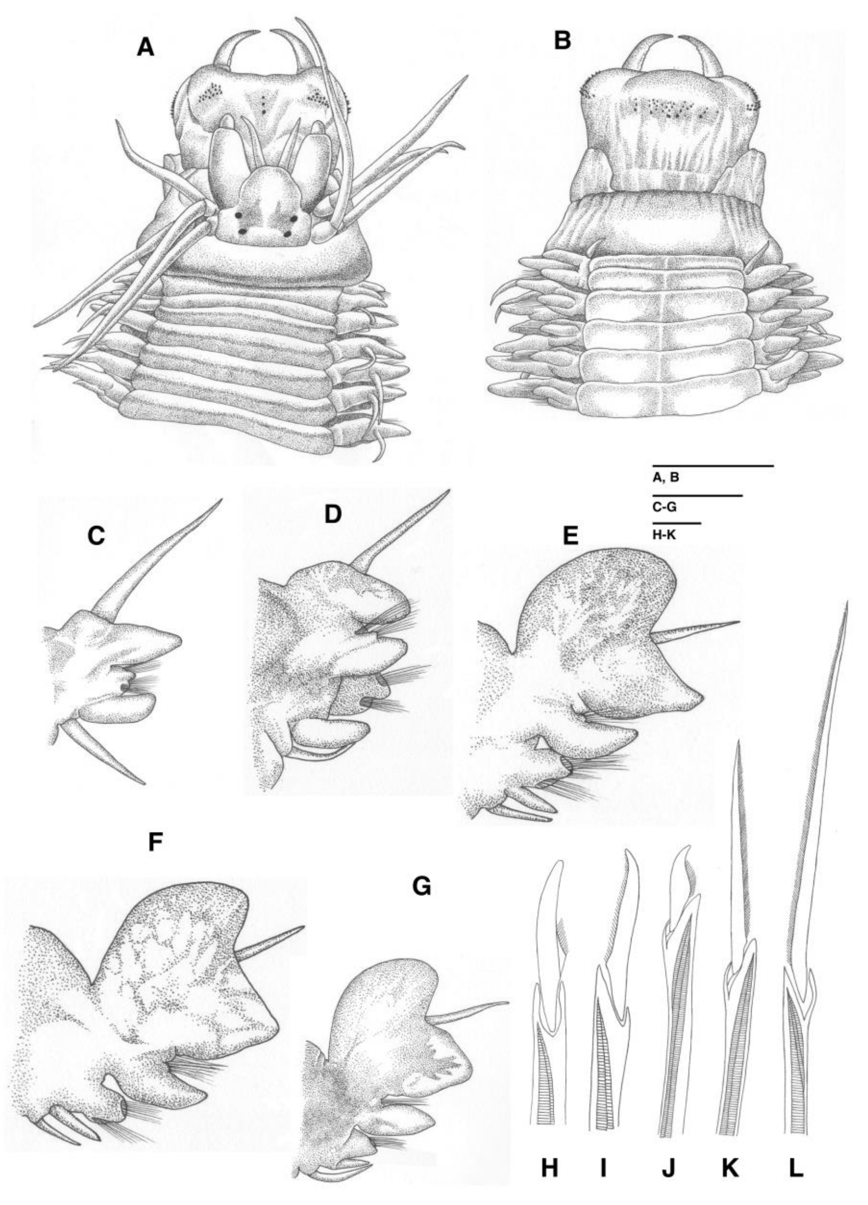

Fig. 22. *Cheilonereis shishidoi* (Izuka, 1912), (A–L) NIBRIV0000781323. (A, B) Dorsal and ventral views of anterior end with the everted proboscis. (C–G) Anterior view of parapodium 1 (C); 10 (D); 56 (E); 75 (F); 98 (G). (H) Homogomph falciger from notochaetae in parapodium 75. (I) Heterogomph falciger from lower neurochaetae in parapodium 7. (J) Heterogomph falciger from upper neurochaetae in parapodium 56. (K) Heterogomph spiniger from lower neurochaetae in parapodia 5. (L) Homogomph spiniger from notochaetae in parapodia 56. Scale bars: 5 mm in (A, B); 2 mm in (C–G); 0.03 mm in (H–L).

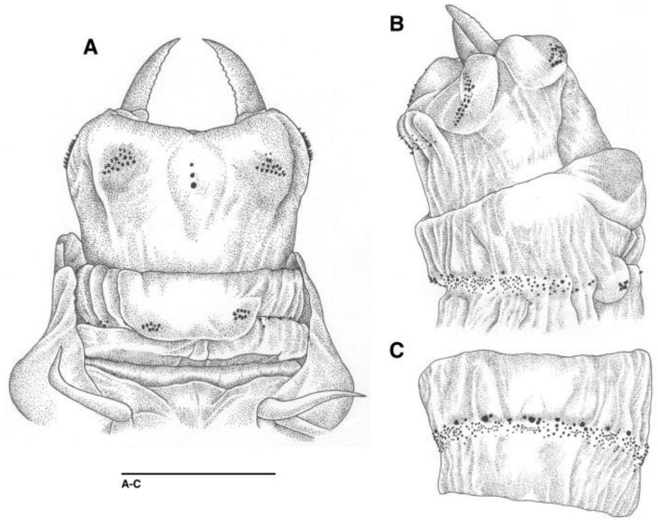

Fig. 23. Proboscis of *Cheilonereis shishidoi* (Izuka, 1912), (A) NIBRIV0000781323; (B–C) NIBRIV0000781322. (A) Dorsal view of anterior end with paragnaths on area I, II and VI, (B) Lateral view of anterior end with paragnaths. (C) Ventral vew of anterior end with paragnaths on area VII–VIII. Scale bar: 5 mm.

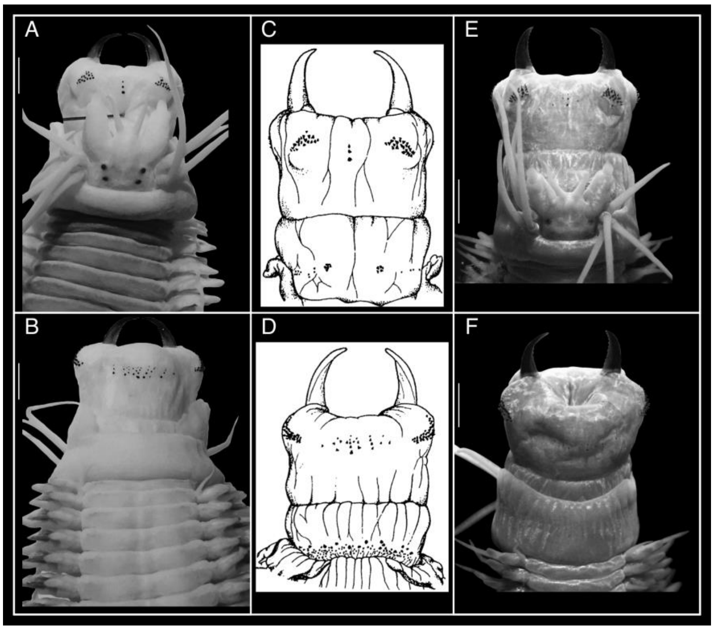

Fig. 24. Dorsal and ventral views of everted proboscis of two *Cheilonereis* species. (A, B) *C. shishidoi* (Izuka, 1912) (NIBRIV0000781323). (C, D) *C. cyclurus sensu* Imajima, 1972. (E, F) *C. cyclurus* (Harrington, 1897) (USNM 29056). Scale bars, 2 mm.

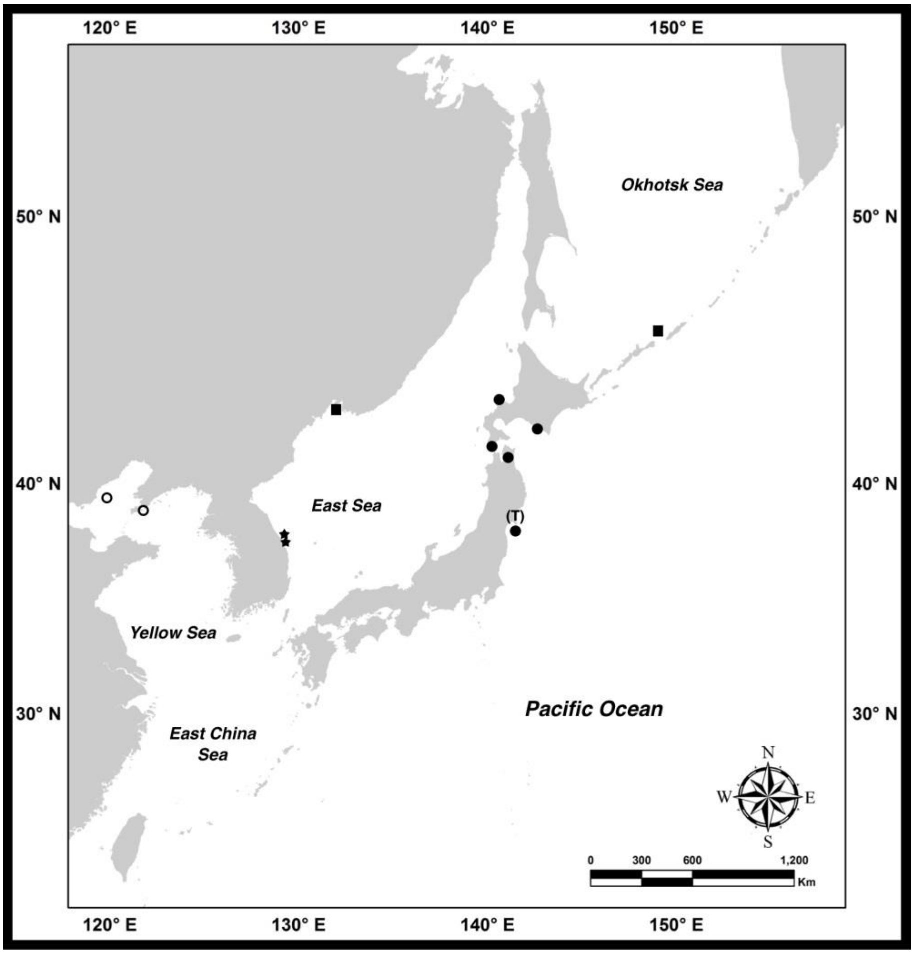

Fig. 25. Distribution of *Cheilonereis shishidoi* (Izuka, 1912) in Northeast Asia based on the present study (★) and the literature. (●) Imajima (1972), (■) Uschakov (1965), (○) Wu et al. (1985). (T) Type locality.

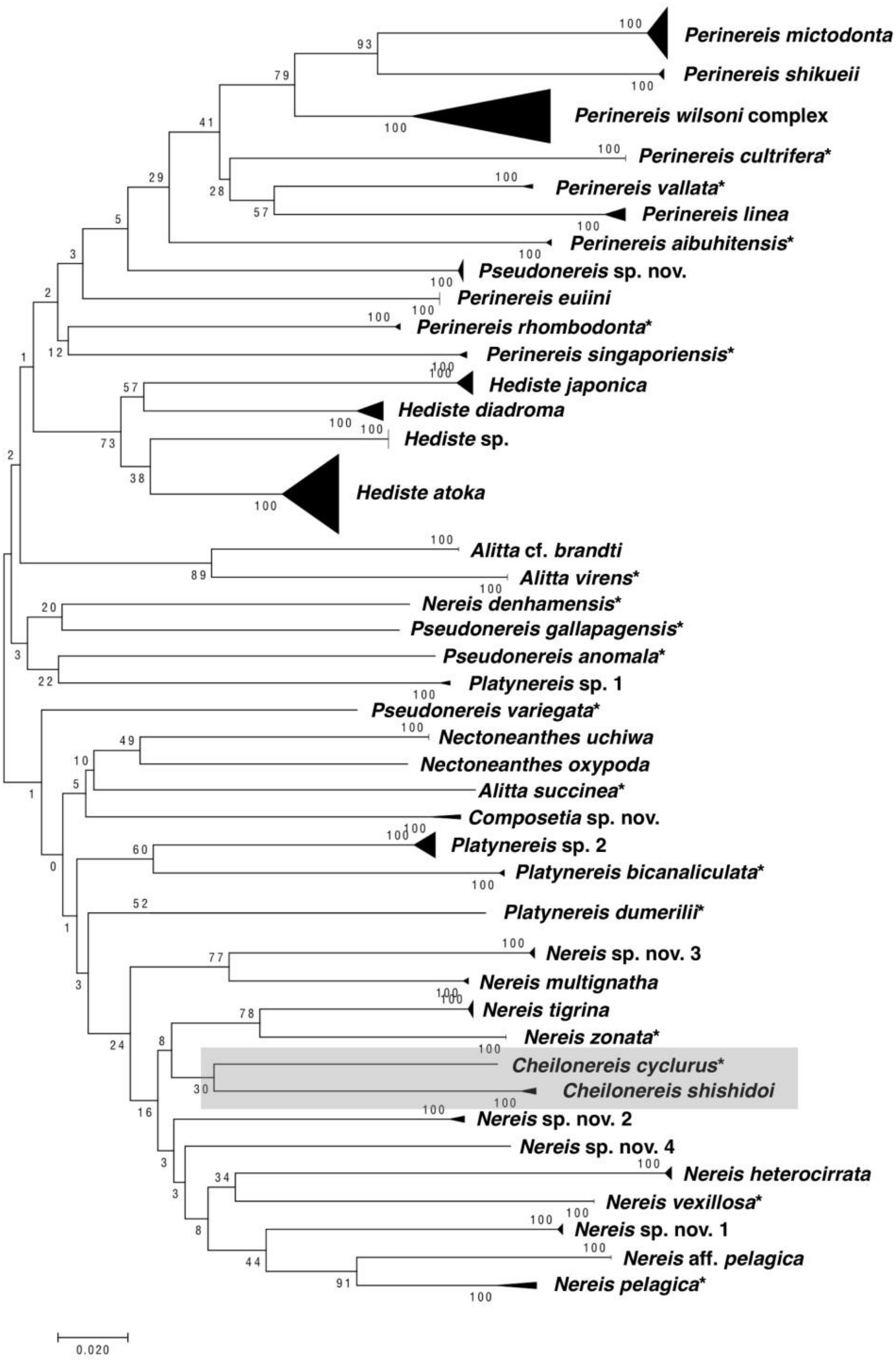

Fig. 26. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray box represents the difference between *Cheilonereis shishidoi* (Izuka, 1912) and *C. cyclurus* (Harrington, 1897).

Table 11. Variation in paragnath numbers in area I to VI on proboscis of *Cheilonereis shishidoi* (Izuka, 1912). Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Locality	I	II(L)	II(R)	III	IV(L)	IV(R)	V	VI(L)	VI(R)
Korea (n=10) (Present study)	2–4 (2.9±0.6)	12–29 (19.7±5)	16–29 (19.4±3.9)	19–34 (25.8±5.4)	22–34 (27.7±3.5)	26–36 (29.6±2.8)	none	7–12 (9.4±1.6)	6–16 (10.3±2.9)
Japan (Holotype) (Izuka, 1912)	3	16–18		transverse band of densely arranged	25–28		none	8–15	
Japan (n=?) (Imajima, 1972 as *C. cyclurus*)	3	22–24		transverse band in dense arrangement	28–32		none	12–16	
Korea (Paik, 1977 as *C. cyclurus*)	3	22–24		transverse band in dense arrangement	about 20		none	about 15	

Table 12. Comparison of paragnath number of *Cheilonereis shishidoi* (Izuka, 1912) with other congeners.

Species (Locality and reference)	Range of paragnath number					
	I	II*	III	IV*	V	VI*
C. shishidoi (10 non-types) (Korea, present study)	2–4	12–29	19–34	22–36	none	6–16
C. cyclurus (10 non-types) (USA, Bakken, 2005)	2–19	14–37	8–30	17–48	none	7–14
C. cyclurus (3 non-types) (USA, present study)	12–22	13–28	18–26	32–39	none	8–15
C. peristomialis (Type and non-types) (New Zealand, Benham, 1916)	1 or 2 large cones with 2–3 small ones	16	transverse patch in three rows	16	none	an irregular rounded group

*Paragnath numbers on each side.

Table 13. Comparison of chaetal arrangement of *Cheilonereis shishidoi* (Izuka, 1912) with other congeners.

Species (Locality and reference)	Chaetal arrangement		
	notochaetae	upper neurocahetae	lower neurochaetae
C. shishidoi (10 non-types from Korea, 5 topotypes from Japan, present study)	homogomph spinigers and homogomph falcigers (present from posterior chaetigers)	homo or sesquigomph spinigers and heterogomph falcigers	heterogomph spinigers and falcigers
C. cyclurus (10 non-types) (USA, Bakken, 2005)	homogomph spinigers and homogomph falcigers (present from anterior chaetigers)	homogomph spinigers and heterogomph falcigers	heterogomph spinigers and falcigers
C. cyclurus (3 non-types) (USA, present study)	homogomph spinigers and homogomph falcigers (present from anterior chaetigers)	homogomph spinigers and heterogomph falcigers	heterogomph spinigers and falcigers
C. peristomialis (Type and non-types) (New Zealand, Benham, 1916)	homogomph spinigers only	homogomph spinigers and heterogomph falcigers	heterogomph falcigers only

Table 14. Mean pairwise genetic distances (K2P distance) based on COI sequences between *Cheilonereis shishidoi* (Izuka, 1912) and *C. cyclurus* (Harrington, 1897). n = individuals.

Species	*C. shishidoi*	*C. cyclurus*
C. shishidoi (n=3)	0.005	0.173
C. cyclurus (n=1)	0.173	-

Genus *Composetia* Hartmann-Schröder, 1985

Ceratonereis (*Composetia*) Hartmann-Schröder, 1985: 49

Composetia Khlebovich 1996: 122

Type species: *Nereis costae* Grube, 1840, designated by Hartmann-Schröder (1985)

Diagnosis

Prostomium with one pair of antennae, one pair of biarticulated palps with conical palpostyles, four pairs of tentacular cirri with distinct cirrophores. Two pairs of eyes. One apodous anterior segment, longer than other posterior chaetigers. Maxillary ring of pharynx, conical paragnaths: area I, present or absent; II–IV present. Oral ring, paragnaths absent. Dorsal notopodial ligule similar in size on anterior and posterior chaetigers. Prechaetal notopodial lobe present, smaller than dorsal notopodial ligule on anterior chaetigers, usually reduced or absent posteriorly. Dorsal cirrus basally attached to dorsal notopodial ligule on posterior chaetigers, lacking basal cirrophore. Neuropodial postchaetal lobe present, at least on some anterior chaetigers. Notoaciculae absent from chaetigers 1 and 2. Notochaetae: homogomph spinigers. Upper neuro chaetae: homogomph spinigers present, sesquigomph spinigers and falcigers present or absent. Lower neurochaetae: sesquigomph falcigers present or absent, homogomph spinigers present, heterogomph falcigers present or absent, homogomph falcigers on anterior chaetigers absent, posterior chaetigers present or absent (modified from Bakken and Wilson, 2005).

3. *Composetia* sp. nov. (Figs. 27–29)

Materials examined

Type materials

Holotype, NIBRIV0000783839, associated with sessile organisms in subtidal rocky area, 20 m in depth, Seopseom islet, Bomok-dong, Seogwipo-si, Jeju-do, Korea, 7 August 2016, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol.

Non-type materials

NIBRIV0000783688, 1 ind., associated with sessile organisms in subtidal rocky area, 20 m in depth, Seopseom islet, Bomok-dong, Seogwipo-si, Jeju-do, Korea, 7 August 2016, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783689, 1 ind., associated with sessile organisms in subtidal rocky area, 20 m in depth, off Mt. Songak, Daejeong-eup, Seogwipo-si, Jeju-do, Korea, 14 November 2016, collected by Taeseo Park, Seul Yi and Kwang-Soo Kim by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783690, 1 ind., associated with sessile organisms in subtidal rocky area, 20 m in depth, Jigwi islet, Wimi-ri, Namwon-eup, Seogwipo-si, Jeju-do, Korea, 14 April 2013, collected by Sang-Hwi Lee by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783691, 1 ind., associated with sessile organisms in subtidal rocky area, 15 m in depth, Mulsaebawi dive point, Sadong-ri, Ulleung-eup, Ulleung-gun, Gyeongsangbuk-do, Korea, 22 June 2014, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000155557, 1 ind., associated with sessile organisms in subtidal rocky area, 50 m in depth, Beomseom islet, Beophwan-dong, Segwipo-si, Jeju-do, Korea, 26 August 2009, collected by Hyun-Jong Kil by SCUBA diving, fixed in 70% ethanol. NIBRIV0000783692, 1 ind., associated with sessile organisms in subtidal rocky area, 18 m in depth, Hyeongje islet, Sagye-ri, Andeok-myeon, Seogwipo-si, Jeju-do, Korea, 20 November 2016, collected by Taeseo Park, Seul Yi and Kwang-Soo Kim by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783693, 1 ind., associated with sessile organisms in subtidal rocky area, 20 m in depth, Geomundo Is., Samsan-myeon, Yeosu-si, Jeollanam-do, Korea (34°3′48″N, 127°16′91″E), 24 April 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol.

Description of atokes

Holotype, complete with 77 chaetigers, 35 mm long, 2.8 mm and 3.2 mm wide excluding and including parapodia at chaetiger 10, respectively.

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum with stout pigmentation of dark brown color with white transverse stripe on center of each chaetigers in live individuals, with pale pigmentation of brownish cream color in preserved ones.

Prostomium pyriform, slightly wider than long, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with short, globose palpophores and shorter cylindrical palpostyles. Two pairs of eyes arranged trapezoidally; gap of anterior pair slightly wider than posterior pair (Fig. 27A). Dark brown pigmentation present on prostomium and palps in live specimen.

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 4 in holotype (4–5 in other materials examined) (Fig. 28A).

Proboscis with pair of dark brown amber jaws, each with 4 teeth of serrated inner margin (Fig. 27A, B). Conical paragnaths present on maxillary ring only except area I. Paragnath numbers and arrangements in holotype as follows (range in other material given in parentheses): area I, none; area II, 9 (4–9) on left and 8 (4–8) on right, arranged in two rows; area III, 1 (1–2); area IV, 8 (6–10) on left and 8 (5–10) on right, arranged in triangular patch (Table 15; Figs. 27A, B; 28A, B).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with reduced notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus (Fig. 27C).

Notopodia consisting of dorsal cirrus, dorsal ligule, prechaetal lobe, and ventral ligule in biramous parapodia (Fig. 27C–I). Dorsal cirri slender, longer than notopodial dorsal ligule throughout. Notopodial dorsal ligule sub-triangular with tapering tip in anterior parapodia (Fig. 27D, E), gradually reduced in posterior parapodia (Fig. 27H, I). Notopodial prechaetal lobe shorter than notopodial dorsal and ventral ligules, gradually reducing posteriorly (Fig. 27D, F, H). Notopodial ventral ligule sub-triangular with tapering tip, slightly shorter than notopodial dorsal ligule in anterior parapodia (Fig. 27D, E), subequal to notopodial dorsal ligule in middle parapodia (Fig. 27F, G), slightly longer than notopodia dorsal ligule (Fig. 27H, I).

Neuropodia consisting of acicular ligule, postchaetal lobe, ventral ligule, and ventral cirrus throughout (Fig. 27C–I). Acicular ligule sub-triangular, subequal to notopodial ventral ligule in anterior parapodia, reduced posteriorly (Fig. 27D, E, H, I) Postchaetal lobe sub-triangular, projecting beyond end of acicular ligule in anterior and posterior parapodia, reduced and not projecting beyond end of acicular ligule in posterior parapodia. Neuropodial ventral ligule digitate with tapering tip throughout. Ventral cirri slender, shorter than acicular ligules throughout (Fig. 27D, E, H, I).

Notochaetae all homogomph spinigers; blades long with finely serrated edge (Fig. 27K). Upper neurochaetae consisting of heterogomph falcigers with serrated median blades (Fig. 27J), and homogomph spinigers with long serrated blades. Lower neurochaetae consisting of heterogomph falcigers with serrated median blades, and homogomph spinigers with long serrated blades.

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers in *Composetia* sp. nov. are summarized in Table 15.

Habitats

Subtidal zone, commensal with sessile organisms.

Distribution

Type locality: Seopseom islet in Jejudo Island, Korea. Korea (Ullengdo Island, Geomundo Island) (Fig. 29).

Molecular data

The COI sequences obtained from two individuals (Table 4, Appendix 2).

Remarks

Species of *Composetia* are characterized by the following morphological characteristics: (1) the absence of paragnaths in oral ring (Fig. 27A, B; 28A, B), (2) the presence of notopodial prechaetal lobes (Fig. 27D) and the reduction or absence of notopodial prechaetal lobes in posterior parapodia (Fig. 27H, I), and (3) the presence of neuropodial postchaetal lobes at least on some anterior parapodia (Fig. 27E). Morphological characteristics of the present specimens (collected from Korean waters) fit the generic diagnosis of *Composetia*.

Composetia sp. nov. is similar to *C. scotiae* (Berkeley and Berkeley, 1956) (type locality: Mitchell Bay, Nova Scotia, Canada) and *C. irritabilis* (Webster, 1879) (type locality: Virginia, USA). However, the present new species differs from them in the following characteristics: (1) the absence of sesquigomph chaetae, in contrast to the presence of those in *C. irritabilis*, and (2) few numbers (1–2, usually 1) of paragnaths present in area III (Fig. 27B, 28B), in contrast to larger numbers of those in *C. irritabilis* and *C. scotiae* (Table 16).

Table 15. Variation in paragnath numbers in area II to IV on proboscis of *Composetia* sp. nov. Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Locality	I	II(L)	II(R)	III	IV(L)	IV(R)
Korea (n=8) (present study)	none	4–9 (6.6±1.7)	4–8 (6.1±1.6)	1–2 (1.3±0.5)	6–10 (7.5±1.4)	5–10 (7.6±1.7)

Table 16. Comparison of key characteristics of *Composetia* sp. nov. with two closely similar species.

Species (Locality and reference)	Range of paragnath number				Sesquigomph chaetae
	I	II	III	IV	
C. sp. nov. (8 type and non-types) (Korea, present study)	none	4–9	1–2	5–10	absent
C. irritabilis (14 types and non-types) (USA, Bakken and Wilson, 2005)	none	5–10	19–34	5–13	present
C. scotiae (3 types) (Canada, Bakken and Wilson, 2005)	1	4–7	0–5	13–17	absent

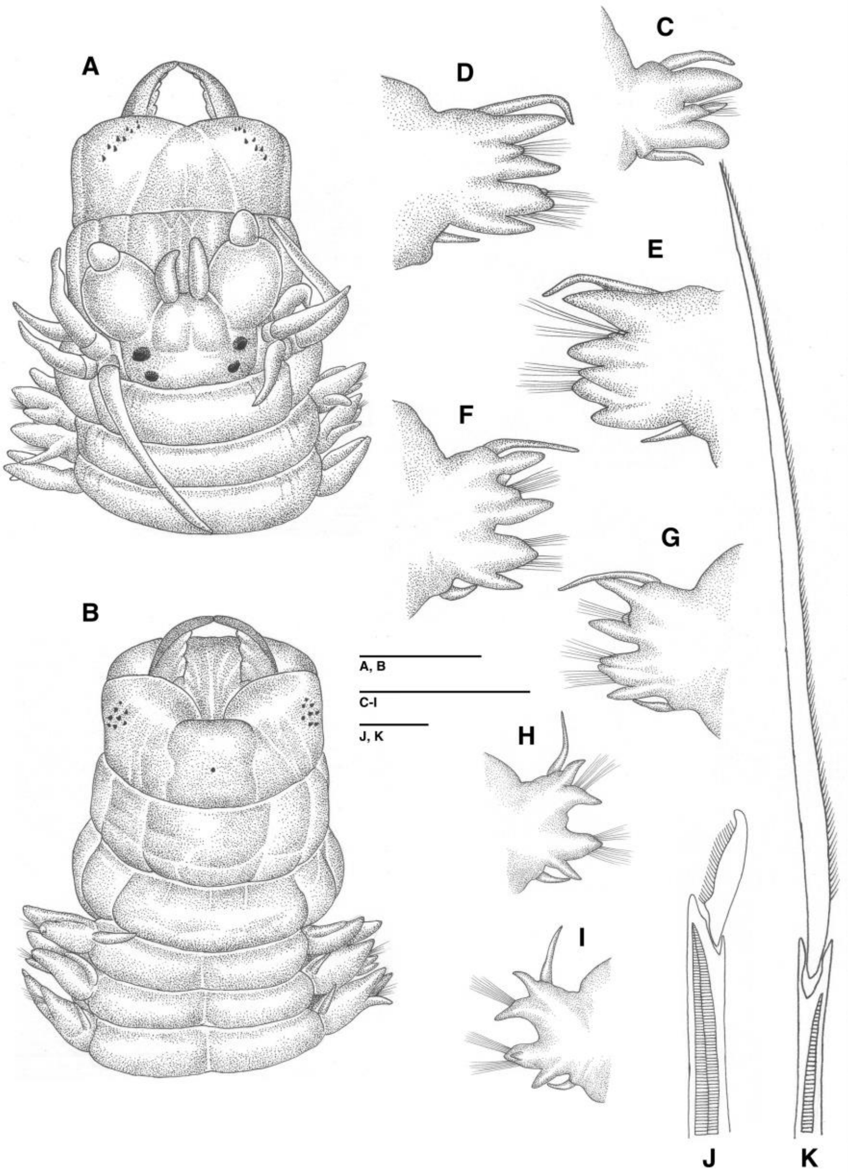

Fig. 27. *Composetia* sp. nov., holotype, NIBRIV0000783839. (A, B) Dorsal and ventral views of anterior end with the everted proboscis. (C) Anterior view of parapodium 1. (D, E) Anterior and posterior views of parapodium 13. (F, G) Anterior and posterior views of parapodium 24. (H, I) Anterior and posterior views of parapodium 48. (J) Heterogomph falciger from upper neurochaetae in parapodium 13. (K) Homogomph spiniger from notochaetae in parapodium 13. Scale bar: 1 mm in (A–I); 0.02 mm in (J, K).

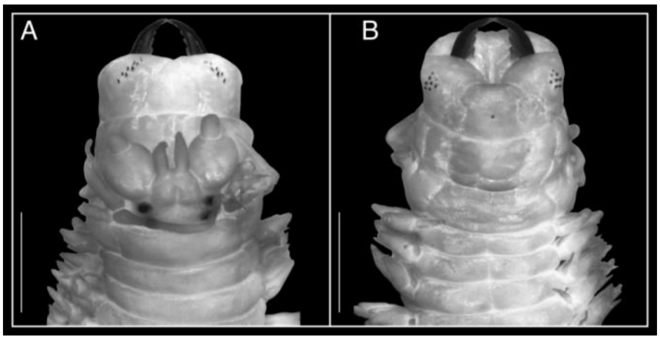

Fig. 28. Dorsal and ventral views of everted proboscis of *Composetia* sp. nov. Scale bars, 1 mm.

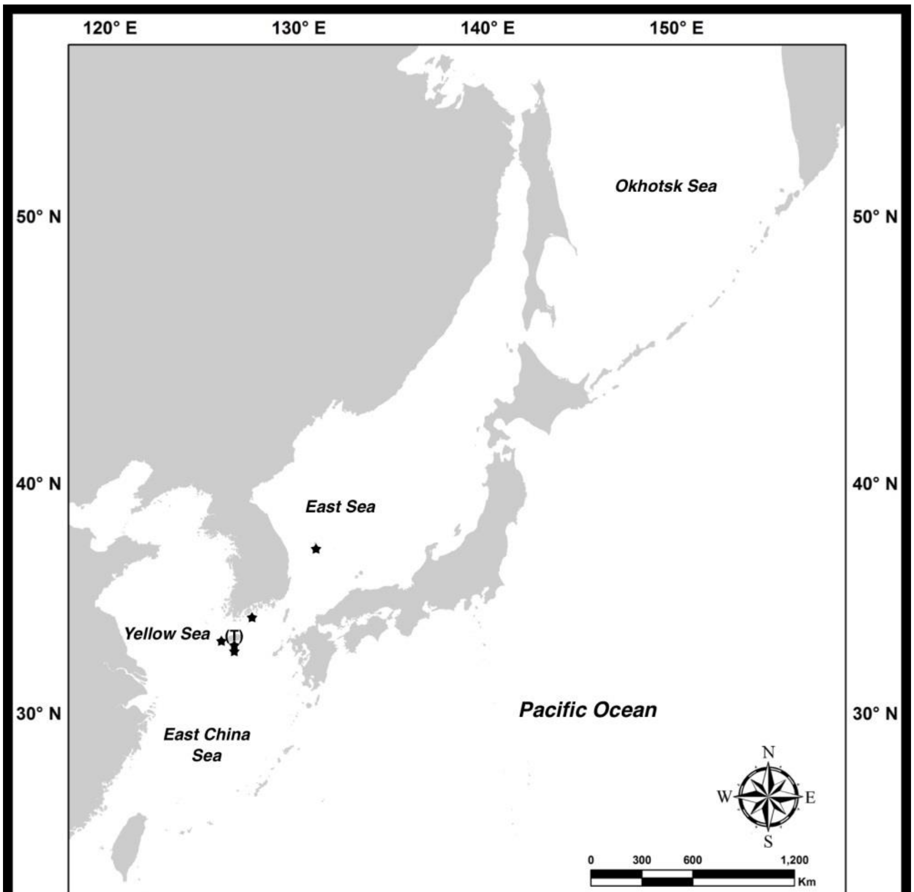

Fig. 29. Distribution of *Composetia* sp. nov. in Northeast Asia based on the present study (★). (T) Type locality.

Genus *Hediste* Malmgren, 1867

Hediste Malmgren, 1867: 165

Type species: *Hediste diversicolor* (O. F. Müller, 1776)

Diagnosis

Eversible proboscis with conical paragnaths on both maxillary and oral rings. Four pairs of tentacular cirri; parapodia biramous except for the first 2 chaetigers. Notochaetae homogomph spinigers. Neurochaetae homogomph spinigers with or without heterogomph spinigers, and heterogomph falcigers with or without homogomph falcigers. One or a few thick simple chaetae present in upper acicular fascicle in posterior neuropodia (Sato and Nakashima, 2003).

4. *Hediste atoka* Sato and Nakashima, 2003 (Figs. 30, 31, 38A, B)

Hediste atoka Sato and Nakashima, 2003: 426–435, figs. 1, 10, 28–43.

Neanthes japonica: Kikuchi, 1998: 125–146, figs. 1–12.

Materials examined

Type materials

Holotype of *Hediste atoka* Sato and Nakashima, 2003 (NSMT-Pol-H454), complete mature female, Shinjogawa River, Amori-shi, Aomori Prefecture, Japan, 3 June 1992, collected by Masanori Sato.

Non-type materials

NIBRIV0000781336, 21 inds, under the silty sediment, Gyungpoho Lake, Gangmun-dong, Gangneung-si, Gangwon-do, Korea (37°47′45″N, 128°54′48″E), 30 May 2012, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787273, 1 ind., mud flat, Yeongu-ri, Hacheong-myeon, Geoje-si, Gyeongsangnam-do, Korea (34°58′51″N, 128°37′43″E), 23 March 2013, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787275, 2 inds., Wangpicheon River, Uljin-gun, Gyeongsangbuk-do, Korea, 18 May 2010, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787277, 9 inds., under the sandy sediment, Sehwa Beach, Sehwa-ri, Gujwa-eup, Jeju-si, Jeju-do, Korea (33°31′2″N, 126°52′12″E), 10 March 2013, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787278, 10 inds., mud flat, Dadae-ri, Nambu-myeon, Geoje-si, Gyeongsangnam-do, Korea (34°44′7″N, 128°37′49″E), 20 March 2012, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787279, 24 inds., Namdaecheon River, Gangneung-si, Gangwon-do, Korea (37°46′33″N, 128°56′20″E), 1 June 2012, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787280, 22 inds., Osipcheon River, Obun-dong, Samcheok-si, Gangwon-do, Korea (37°25′49″N, 129°11′10″E), 31 May 2012, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787276, 2 inds., Shinjo River, Aomori, Aomori Prefecture, Japan, 19 June 2007, collected by Masanori Sato fixed in ethanol.

Diagnosis

Large number (20.2±5.6, n=89, present study) of paragnaths on each of right and left sides of proboscis in area II. Homogomph falciger absent and heterogomph spinigers present in neuropodia. Neuropodial postchaetal ligule tapering to digitate lobe only in anterior chaetaegers. Sexual maturity without any epitokous metamorphosis in both males and females. (modified from Sato and Nakashima, 2003).

Description of atokes

Body stout anteriorly, gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Preserved specimens colored whitish cream with dark brown pigmentation on anterior dorsal surface.

Prostomium pyriform, slightly wider than long, with pair of smooth tapered antennae inserted at anterior end. Pair of palps with massive palpophores about twice as long as antennae and short round palpostyles. Two pairs of eyes arranged trapezoidally; gap of anterior pair slightly wider than posterior pair (Figs. 30A, 38A).

Peristomium slightly longer than other chaetigers, with four pairs of tentacular cirri of different length; posterior dorsal tentacular cirri longest, reaching back to around chaetiger 5 (Figs. 30A, B; 38A, B).

Proboscis with pair of brown amber jaws, each with 5–8 teeth of serrated inner margin. Conical paragnaths, usually with pointed tip, present on both maxillary and oral rings except area V. Paragnath numbers and arrangements as follows: area I, 0–5; area II, 9–34 on left and 6–35 on right, arranged in two to three arched rows; area III, 20–75 in transverse band; area IV, 7–45 on left and 10–45 on right, arranged in three arched rows; area V, none; area VI, 1–8 on each side, in small clusters; areas VII–VIII, 13–36 in single transverse row (Table 17; Figs. 30A, B; 38A, B).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with reduced notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, postchaetal lobe, ventral ligule, and ventral cirrus.

Notopodia consisting of dorsal cirrus, dorsal ligule, prechaetal lobe, and ventral ligule in biramous parapodia (Fig. 30C–H). Dorsal cirri slender, tapering, not reaching tip of superior ligule. All notopodial ligules subtriangular with tapering tip. Notopodial dorsal ligule thick in anterior chaetigers (Fig. 30C–F), thinner in middle and posterior chaetigers (Fig. 30G–J), most expanded in middle chaetigers. Notopodial prechaetal lobe subtriangular with tapering tip, subequal to notopodial ventral ligule in anterior chaetigers (Fig. 30C, D), gradually diminishing in size in middle chaetigers and absent in posterior chaetigers (Fig. 30I, J).

Neuropodia consisting of ventral cirrus, acicular ligule, neuropodial postchaetal ligule and neuropodial ventral ligule. Acicular ligule and neuropodial postchaetal ligule conical with tapering tip, of similar lengths, completely separate in anterior chaetigers (Fig. 30C–F), fused at following chaetigers; tapering tip of neuropodial postchaetal ligule diminishing to digitate lobe, present up to around chaetiger 20, and absent in following chaetigers (Fig. 30G–J). Acicular ligule with blunt tip. Neuropodial ventral ligule conical. Ventral cirrus slender with tapering tip. Neuropodial ventral ligule and ventral cirrus gradually diminishing in size in posterior chaetigers.

Notochaetae all homogomph spinigers; blades long with finely serrated edge (Fig. 30K). Upper neurochaetae consisting of homogomph spinigers (Fig. 30L) and heterogomph falcigers in anterior and middle chaetigers. Neuropodial homogomph spinigers similar to notopodial ones in shape and size. Heterogomph falcigers long type with serrated blade; thick simple chaetae with tapering tip present instead of heterogomph falcigers in posterior chaetigers. Lower neurochaetae consisting of homogomph spinigers, heterogomph spinigers (Fig. 30M), and heterogomph falcigers (Fig. 30N).

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers collected from seven localities are summarized in Table 17.

Habitats

Sandy and muddy tidal flat, estuary area in a river.

Distribution

Northast Asia (Korea, Japan) (Fig. 31).

Molecular data

The COI sequence data obtained from 37 individuals (Table 4, Appendix 2).

Remarks

See remarks part of *Hediste* sp. on page 107.

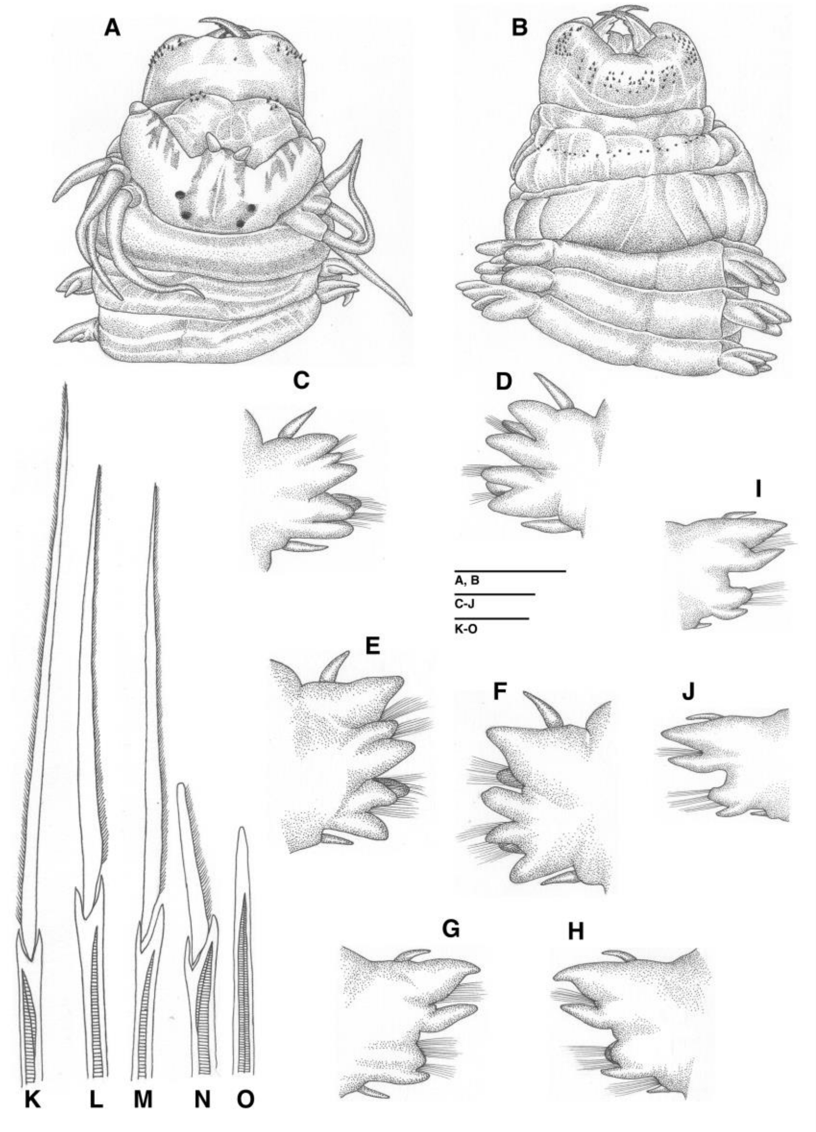

Fig. 30. *Hediste atoka* Sato and Nakashima 2003, NIBRIV0000781336. (A, B) Dorsal and ventral views of anterior end with the everted proboscis. (C, D) Anterior and posterior views of parapodium 3. (E, F) Anterior and posterior views of parapodium 10. (G, H) Anterior and posterior views of parapodium 36. (I, J) Anterior and posterior views of parapodium 61. (K) Homogomph spiniger from notochaetae in parapodium 10. (L) Heterogomph spiniger from upper neurochaetae in parapodium 10. (M) Heterogomph spiniger from lower neurochaetae in parapodium 10. (N) Heterogomph falciger from lower neurochaetae in parapodium 20. (O) Simple chaeta from upper neurochaetae in parapodium 61. Scale bars: 2 mm in (A, B); 1 mm in (C–J); 0.03 mm in (K–O).

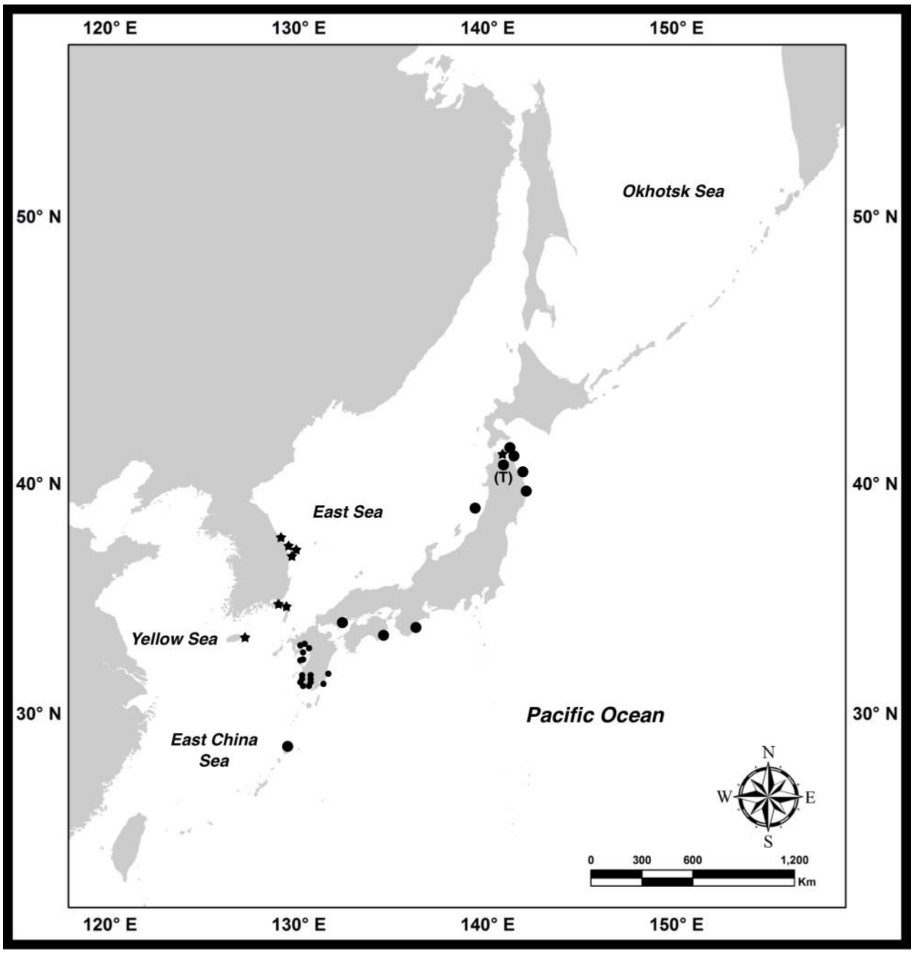

Fig. 31. Distribution of *Hediste atoka* Sato and Nakashima 2003 in Northeast Asia based on the present study (★) and the literature. (●) Sato and Nakashima (2003). (T) Type locality.

Table 17. Variation in paragnath numbers in area I to VIII on proboscis of *Hediste atoka* Sato and Nakashima 2003. Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Locality	**I**	**II(L)**	**II(R)**	**II (Total)**	**III**	**IV(L)**	**IV(R)**	**IV (Total)**	**V**	**VI(L)**	**VI(R)**	**VI (Total)**	**VII–VIII**
Korea (n=87) (Present study)	0–5 (1.5±0.9)	9–34 (20.1±5.5)	6–35 (20.2±5.9)	16–68 (40.3±11)	20–75 (33.3±5)	7–45 (26±7)	10–45 (25.9±7)	23–87 (51.9±13)	0	1–8 (5±1.4)	1–8 (5±1.4)	5–16 (10±2.3)	13–36 (21.8±4.7)
Japan (n=2) (Present study)	1–3 (2±1.4)	18–25 (21.5±5)	21–23 (22±1.4)	41–46 (43.5±3.5)	28–40 (34±8.5)	22–34 (28±8.5)	22–33 (27.5±7.8)	44–67 (55.5±16.3)	0	5–7 (6±1.4)	5–6 (5.5±0.7)	10–13 (11.5±2.1)	13–19 (16±4.2)
Japan (n=176) (Sato and Nakashima, 2003)	0–8	-	-	29–82	23–79	-	-	34–92	0	-	-	1–17	9–35
Japan (Holotype) (Sato and Nakashima, 2003)	3	21	21	42	36	26	25	51	0	5	6	11	14

5. *Hediste diadroma* Sato and Nakashima, 2003 (Figs. 32, 33, 38C, D)

Hediste diadroma Sato and Nakashima, 2003: 415–426, figs. 10, 16–27, 38–43.

Nereis japonica: Kagawa, 1955: 11–16, fig. 5; Okada, 1960: 63–71, pls. 1–4.

Neanthes japonica: Sun et al., 1980: 100–110, figs. 1–3; Sato and Osanai, 1986: 263–270, figs 1–7; Qiu and Wu, 1993: 360–367, figs. 1, 2.

Hediste japonica: Sato, 2001: 66–86, Rouse and Pleijel, 2001: pl. 5c.

Materials examined

Type materials

Holotype of *Hediste diadroma* Sato and Nakashima, 2003 (NSMT-Pol-H456), complete mature female, mouth of Omoigawa River, Aira-cho, Kagoshima Prefecture, Japan, 25 February 1986, collected by Masanori Sato. Paratype of *Hediste diadroma* Sato and Nakashima, 2003 (NSMT-Pol-P456), Omoigawa River, Aira-cho, Kagoshima Prefecture, 19 February 1988, collected by Masanori Sato.

Non-type materials

NIBRIV0000787274, 5 inds., mud flat, Chilcheondo Is., Daegok-ri, Hacheong-myeon, Geoje-si, Gyeongsangnam-do, Korea (35°0′38″N, 128°38′30″E), 21 March 2012, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787273, 1 ind.; NIBRIV0000783847, 1 ind.; NIBRIV0000783848, 11 inds., mud flat, Chilcheondo Is., Yeongu-ri, Hacheong-myeon, Geoje-si, Gyeongsangnam-do, Korea (34°58′51″N, 128°37′43″E), 23 May 2013, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000783849, 2 inds., near Taehwa bridge, Taehwa River, Sinjeong-dong, Man-gu, Ulsan-si, Korea, 25 May 2009, fixed in 80% ethanol. NIBRIV0000783850, 2 inds., estuary area of Seomjin River, Jeollanam-do, Korea, 19 May 2009, fixed in 80% ethanol. NIBRIV0000787271, 1 ind., Omoigawa River, Aria-cho, Kagoshima Prefecture, Japan, 30 October 2012, collected by Masanori Sato fixed in ethanol. NIBRIV0000787272, 1 ind., Saigogawa River, Shimabara-city, Nagasaki

Prefecture, Japan, 2 August 2012, collected by Masanori Sato.

Diagnosis

Moderate number (10–20 in most cases; 13.9±2.5, n=24, present study) of paragnaths on each of right and left sides of proboscis in area II. Homogomph falciger absent and heterogomph spinigers present in neuropodia. Neuropodial postchaetal ligule tapering to digitate lobe only in anterior chaetaegers. At epitokous stage, delicate epitoke-specific sesquigomph spinigers added in all notopodial and neuropodial fascicles (modified from Sato and Nakashima, 2003).

Description

Body stout anteriorly, gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Preserved specimens colored whitish cream with dark brown pigmentation on anterior dorsal surface.

Prostomium pyriform, slightly wider than long, with pair of smooth tapered antennae inserted at anterior end. Pair of palps with massive palpophores about twice as long as antennae and short round palpostyles. Two pairs of eyes arranged trapezoidally; gap of anterior pair slightly wider than posterior pair. Dark brown pigmentation partially present on dorsal anterior surface of prostomium and palpophore (Figs. 32A, B; 38C, D).

Peristomium slightly longer than other chaetigers, with four pairs of tentacular cirri of different length; posterior dorsal tentacular cirri longest, reaching back to around chaetiger 5 (Figs. 32A, B; 38C, D).

Proboscis with pair of brown amber jaws, each with 5–8 teeth of serrated inner margin. Conical paragnaths, usually with pointed tip, present on both maxillary and oral rings except area V. Paragnath numbers and arrangements as follows: area I, 0–2; area II, 11–18 on left and 8–22 on right, arranged in two to three arched rows; area III, 17–47 in transverse band; area IV, 13–31 on left and 14–26 on right, arranged in three arched rows; area V, none; area VI, 3–8 on left and 1–8 on right, in small clusters; areas VII–VIII, 13–37 in single transverse row. (Table 18; Figs. 32A, B; 38C, D).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with reduced notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, postchaetal lobe, ventral ligule, and ventral cirrus.

Notopodia consisting of dorsal cirrus, dorsal ligule, prechaetal lobe, and ventral ligule in biramous parapodia (Fig. 32C–E). Dorsal cirri slender, tapering, not reaching tip of notopodial dorsal ligule, gradually diminishing in size in posterior chaetigers. All notopodial ligules subtriangular with tapering tip. Notopodial dorsal ligule thick in anterior chaetigers, thinner in middle and posterior chaetigers, most expanded in middle chaetigers. Notopodial prechaetal lobe subtriangular with tapering tip, subequal to notopodial ventral ligule in anterior chaetigers (Fig. 32C), gradually diminishing in size in middle chaetigers and reduced acicular papilla in posterior chaetigers (Fig. 32E).

Neuropodia consisting of ventral cirrus, acicular ligule, postchaetal ligule and ventral ligule. Acicular ligule and neuropodial postchaetal ligule conical with tapering tip, of similar lengths, completely separate in anterior chaetigers (Fig. 32C), fused at following chaetigers; tapering tip of neuropodial postchaetal ligule diminishing to digitate lobe, present up to around chaetiger 20, and absent in following chaetigers (Fig. 32D, E). Acicular ligule with blunt tip. Neuropodial ventral ligule conical. Ventral cirrus slender with tapering tip. Neuropodial ventral ligule and ventral cirrus gradually diminishing in size in posterior chaetigers.

Notochaetae all homogomph spinigers; blades long with finely serrated edge (Fig. 32H). Upper neurochaetae consisting of homogomph spinigers and heterogomph falcigers in anterior and middle chaetigers. Neuropodial homogomph spinigers similar to notopodial ones in shape and size. Heterogomph falcigers long type with serrated blade; thick simple chaetae with tapering tip present instead of heterogomph falcigers in posterior chaetigers.

Lower neurochaetae consisting of homogomph spinigers, heterogomph spinigers, and heterogomph falcigers. Epitoke-specific chaetae added to all notopodial and neuropodial fascicles in mature adults (Fig. 32F, G, I).

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers are summarized in Table 18.

Habitats

Sandy and muddy tidal flat.

Distribution

Northeast Asia (The coast of China, Korea, and Japan) (Fig. 33).

Molecular data

The COI sequence data obtained from eight individuals (Table 4, Appendix 2).

Remarks

See remarks part of *Hediste* sp. on page 107.

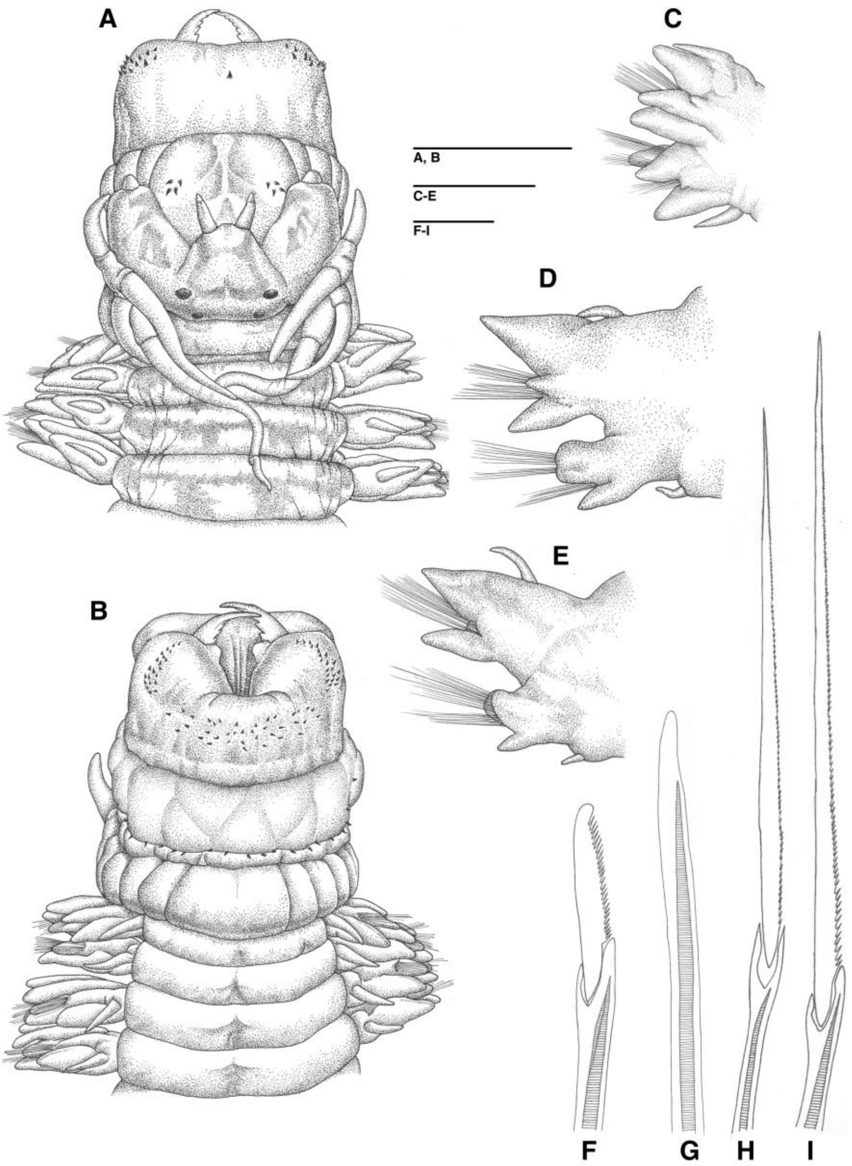

Fig. 32. *Hediste diadroma* Sato and Nakashima 2003, NIBRIV0000787274. (A, B) Dorsal and ventral views of anterior end with the everted proboscis. (C–E) Anterior views of parapodium 4 (C), 30 (D), 60 (E). (F) Heterogomph falciger from lower neurochaetae in parapodium 20. (G) Simple chaeta from upper neurochaetae in parapodium 57. (H) Homogomph spiniger from notochaetae in parapodium 24. (I) Heterogomph spiniger from lower neurochaetae in parapodium 3. Scale bars: 2 mm in (A, B); 1 mm in (C–E); 0.03 mm in (F–I).

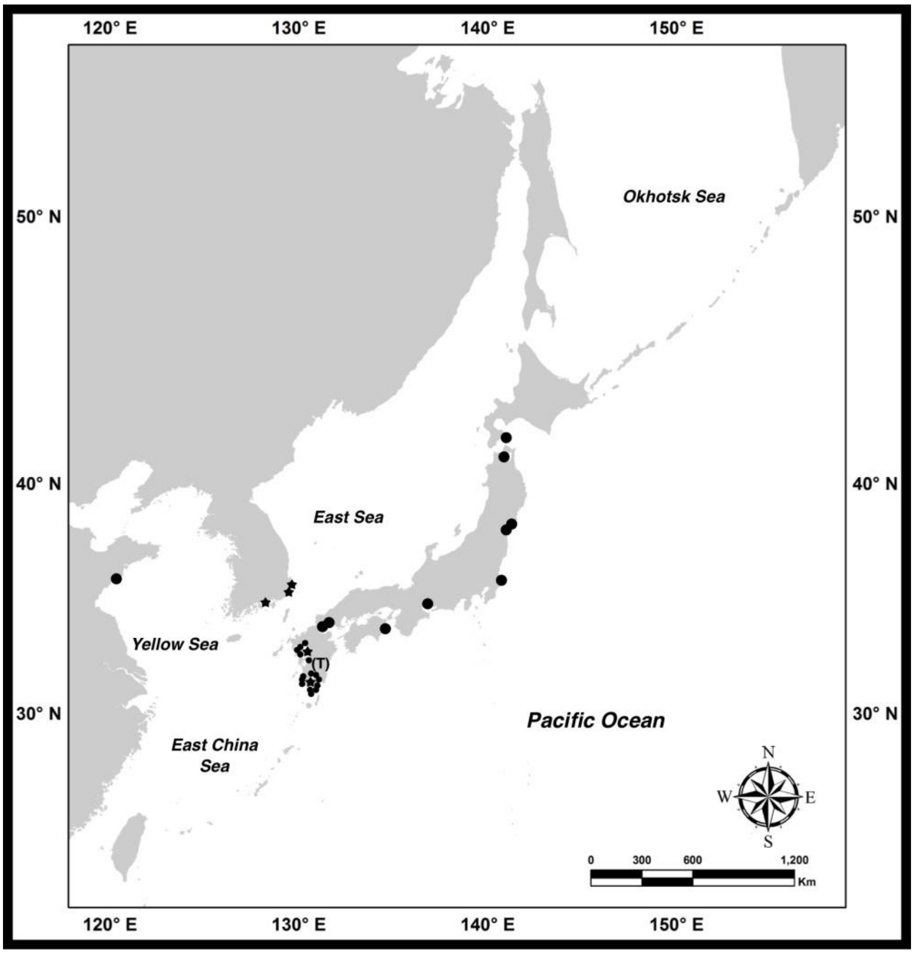

Fig. 33. Distribution of *Hediste diadroma* Sato and Nakashima 2003 in Northeast Asia based on the present study (★) and the literature. (●) Sato and Nakashima (2003). (T) Type locality.

Table 18. Variation in paragnath numbers in area I to VIII on proboscis of *Hediste diadroma* Sato and Nakashima 2003. Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Locality	I	II(L)	II(R)	II (Total)	III	IV(L)	IV(R)	IV (Total)	V	VI(L)	VI(R)	VI (Total)	VII–VIII
Korea (n=22) (Present study)	0–2 (1±0.7)	11–18 (13.7±2)	8–22 (14±3.2)	20–37 (27.8±4.6)	17–47 (31.7±6.9)	13–31 (20.3±4.4)	14–26 (20±3.5)	27–57 (40.2±7.5)	0	3–8 (5.7±1.2)	1–8 (5±1.4)	5–16 (10.8±2.2)	13–37 (22.6±5.5)
Japan (n=2) (Present study)	1–2 (1.5±0.7)	14–16 (15±1.4)	12–13 (12.5±0.7)	27–28 (27.5±0.7)	31–35 (33±2.8)	20–22 (21±1.4)	17–20 (18.5±2.1)	37–42 (39.5±3.5)	0	4–5 (4.5±0.7)	4–5 (4.5±0.7)	9	14–25 (19.5±7.8)
Japan (n=188) (Sato and Nakashima, 2003)	1–8	-	-	18–52	22–61	-	-	25–67	0	-	-	3–17	11–41
Japan (Holotype) (Sato and Nakashima, 2003)	2	15	16	31	37	24	24	48	0	6	6	12	26

6. *Hediste japonica* (Izuka, 1908) (Figs. 34, 35, 37, 38E, F)

Nereis japonica Izuka, 1908: 295–305, 4 text figs.; Izuka, 1912: 163–169, pl. 17, figs 14–16, 18; 4 text figs.

Neanthes japonica (epitokes): Smith, 1958: 60–73.

Not *Hediste japonica*: Imajima, 1972: 102–105, figs. 30, 37 (= *H. atoka* or *H. diadroma*); Imajima, 1996: 139, fig. 111 (=*H. atoka* or *H. diadroma*); Paik, 1972: 132–133, fig. 3 (= *H. atoka* or *H. diadroma*); Paik, 1977: 196–198, fig. 27 (= *H atoka* or *H. diadroma*); Paik, 1978: 371, pl. 4, figs. 8–9, pl. s, figs. 1–2 (= *H atoka* or *H. diadroma*); Paik, 1979: 54, fig. 7n–p (= *H atoka* or *H. diadroma*); Paik, 1982: 789, pl. 14d–f (= *H atoka* or *H. diadroma*); Paik, 1989: 335–338, pls. 31, 32, figs, 76a, 76b-1–4; text fig. 87 (= *H. atoka* or *H. diadroma*); Sato, 1999: 129–143 (= *H. diadroma*); Sato, 2000: 187–191, figs. 8-2 and 8-3 (= *H. diadroma*); Sato, 2001: 66–86, figs. 4-1-4-10 (= *H. diadroma*); Rouse and Pleijel, 2001: pl. 5c (= *H. diadroma*).

Materials examined

Non-type materials

NIBRIV0000783706, 2 inds., mud flat, Yeonpyeong Harbor, Yeonpyungdo Is., Yeonpyung-myun, Ongjin-gun, Incheon-si, Korea (37°39′47″N, 125°42′42″E), 13 February 2012, collected by Pyung-Gang Lee, fixed in 80% ethanol. NIBRIV0000244195, 16 inds, mud flat, Ganghwado Is., Dongmak Beach, Ganghwa-gun, Incheon-si, Korea, 1 December 2011, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000783705, 4 inds., sediment, Omutagawa River flows into Ariake Sea, Fukuoka Prefecture, Japan, 4 February 2007, collected by Masanori Sato, fixed in ethanol.

Diagnosis

Few (less than 10 in most cases; 8.3±1.5, n=22, present study) large paragnaths on each of right and left sides of proboscis in area II. Homogomph falcigers present, and heterogomph spinigers absent in neuropodia. Neuropodial postchaetal ligule tapering to digitate lobe throughout. Epitokous stage without any addition of epitoke-specific chaetae (modified from Sato and Nakashima, 2003).

Description

Body stout anteriorly, gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Preserved specimens colored whitish cream with dark brown pigmentation on anterior dorsal surface.

Prostomium pyriform, slightly wider than long, with pair of smooth tapered antennae inserted at anterior end. Pair of palps with massive palpophores about twice as long as antennae and short round palpostyles. Two pairs of eyes arranged trapezoidally; gap of anterior pair slightly wider than posterior pair. Longitudinal mid-dorsal groove present on anterior dorsum of prostomium. Dark brown pigmentation partially present on dorsal anterior surface of prostomium and palpophores (Fig. 34A, B).

Peristomium as long as other chaetigers, with 4 pairs of tentacular cirri of different length; posterior dorsal tentacular cirri longest, reaching back to around chaetiger 3–5 (Figs. 34A, B; 38E, F).

Proboscis with pair of dark brown amber jaws, each with 5–6 teeth of serrated inner margin. Conical paragnaths, usually with pointed tip, present on both maxillary and oral rings except area V. Paragnath numbers and arrangements as follows: area I, 1–4; area II, 4–11 on left 5–11 on right side, arranged in two to three arched rows; area III, 27–52 in transverse band; area IV, 7–16 on left and 6–14 on right, arranged in three arched rows; area V, none; area VI, 3–10 on left and 4–10 on right in small clusters; areas VII–VIII, 16–28 in single transverse row (Table 19; Figs. 34A, B; 38E, F). Paragnaths in area II, curved conical shape, larger than the others.

Parapodia of first 2 chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with reduced notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, postchaetal lobe, ventral ligule, and ventral cirrus.

Notopodia consisting of dorsal cirrus, dorsal ligule, prechaetal lobe, and ventral ligule in biramous parapodia (Fig. 34C–J). Dorsal cirri slender, tapering, not reaching tip of notopodial dorsal ligule, gradually diminishing in size in posterior chaetigers. All notopodial ligules subtriangular with tapering tip. Notopodial dorsal ligule thick in anterior chaetigers, thinner in middle and posterior chaetigers, most expanded in middle chaetigers. Notopodial prechaetal lobe subequal to notopodial ventral ligule in anterior chaetigers (Fig. 34C, D), gradually diminishing in size in middle and posterior chaetigers (Fig. 34G–J).

Neuropodia consisting of ventral cirrus, acicular lobe, postchaetal lobe and ventral ligule. Neuropodial acicular lobe and neuropodial postchaetal lobe conical with tapering tip, of similar lengths, completely separate in anterior chaetigers (Fig. 34C, D), fused at basal parts with tapering tips remaining in middle and posterior chaetigers. Neuropodial ventral ligule conical. Ventral cirrus slender with tapering tip. Neuropodial ventral ligule and ventral cirrus gradually diminishing in size in posterior chaetigers.

Notochaetae all homogomph spinigers; blades long with finely serrated edge. Upper neurochaetae consisting of homogomph spinigers and heterogomph falcigers in anterior chaetigers. Neuropodial homogomph spinigers similar to notopodial ones in shape and size. Heterogomph falcigers long type with serrated blade; thick simple chaetae with tapering tip present instead of heterogomph falcigers in posterior chaetigers. Lower neurochaetae consisting of homogomph spinigers, homogomph falcigers, and heterogomph falcigers; homogomph and heterogomph falcigers often indistinguishable.

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers are summarized in Table 19.

Habitats

Muddy tidal flat.

Distribution

East Asia (The coast Korea and Japan) (Fig. 35).

Molecular data

The COI sequence data obtained from 11 individuals (Table 4, Appendix 2).

Remarks

See remarks part of *Hediste* sp. on page 107.

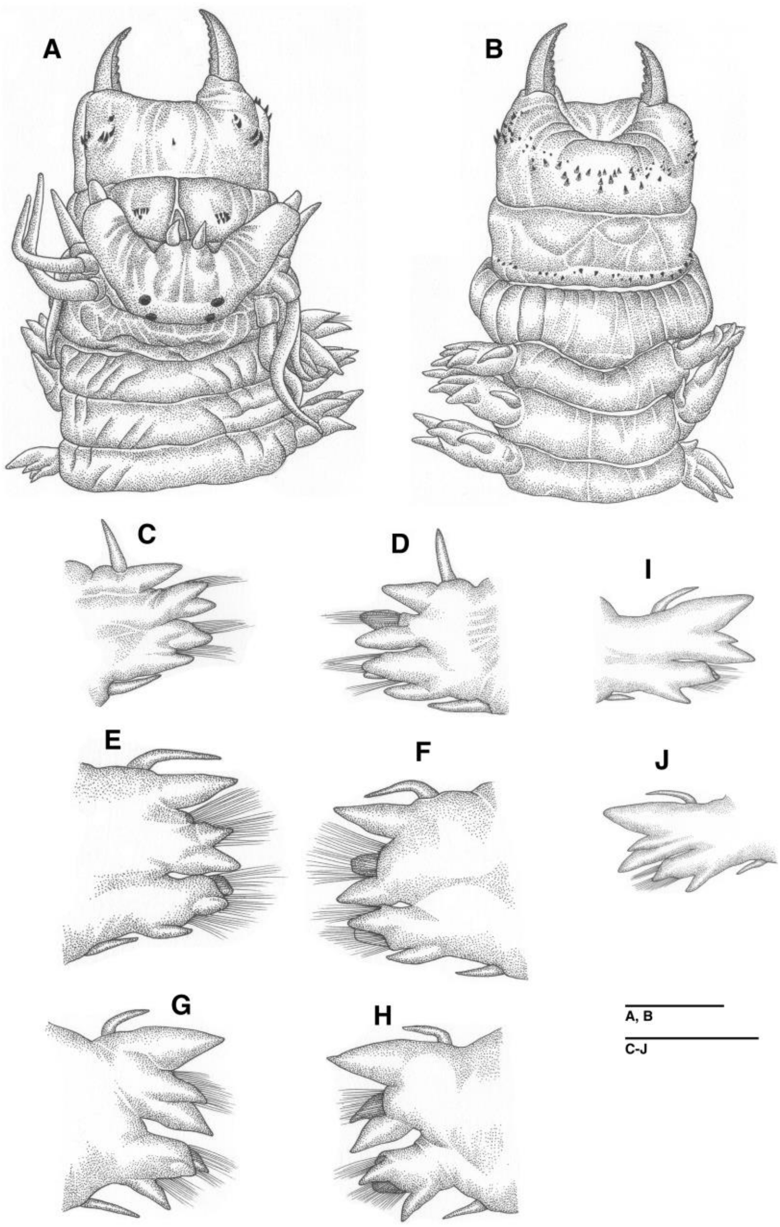

Fig. 34. *Hediste japonica* (Izuka, 1908), NIBRIV0000244195. (A, B) Dorsal and ventral views of anterior end with the everted proboscis. (C, D) Anterior and posterior views of parapodium 6. (E, F) Anterior and posterior views of parapodium 21. (G, H) Anterior and posterior views of parapodium 41. (I, J) Anterior and posterior views of parapodium 78. Scale bars: 2 mm in (A–J).

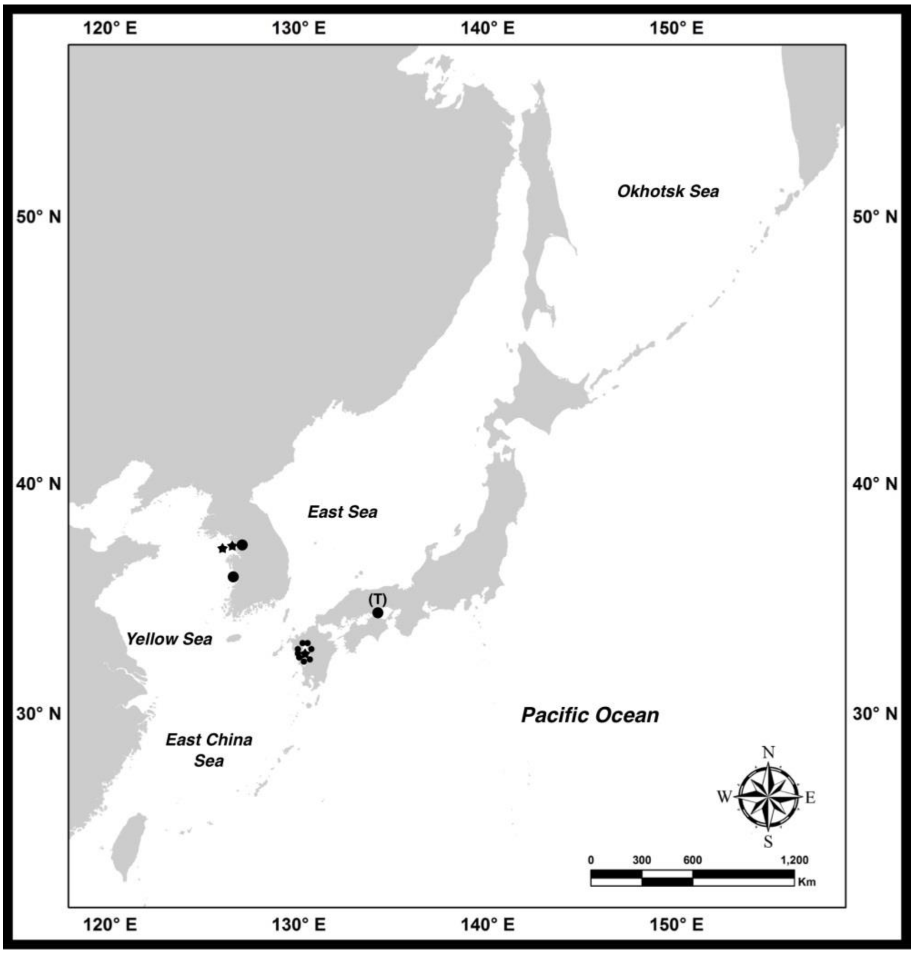

Fig. 35. Distribution of *Hediste japonica* (Izuka, 1908) in Northeast Asia based on the present study (★) and the literature. (●) Sato and Nakashima (2003). (T) Type locality.

Table 19. Variation in paragnath numbers in area I to VIII on proboscis of *Hediste japonica* (Izuka, 1908). Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Locality	**I**	**II(L)**	**II(R)**	**II (Total)**	**III**	**IV(L)**	**IV(R)**	**IV (Total)**	**V**	**VI(L)**	**VI(R)**	**VI (Total)**	**VII–VIII**
Korea (n=18) (Present study)	1–4 (2.1±0.8)	7–11 (8.6±1.2)	5–10 (8.3±1.4)	13–20 (16.8±2)	27–47 (36.4±5)	8–16 (10.9±2.1)	8–14 (10.9±1.6)	17–29 (21.8±3.3)	0	4–10 (7.4±1.8)	4–10 (6.9±1.5)	11–20 (14.3±2.8)	16–28 (22±3.1)
Japan (n=4) (Present study)	1–3 (2.5±1)	4–10 (7.5±2.7)	5–11 (7.8±2.5)	9–21 (15.3±5.1)	35–52 (42.5±7.6)	7–14 (10.8±3)	6–13 (10.5±3.3)	13–27 (21.3±5.9)	0	3–8 (6.3±2.2)	4–8 (6±1.8)	8–15 (12.3±3.4)	20–28 (24.8±3.6)
Japan (n=10) (Sato and Nakashima, 2003)	1–4	-	-	11–22	23–30	-	-	10–21	0	-	-	10–18	19–26
Japan (Lectotype) (Sato and Nakashima, 2003)	2	11	6	17	28	11	10	21	0	8	5	13	22

7. *Hediste* sp.

Materials examined

NIBRIV0000787893, 6 inds., artificial irrigation canal, Geomam-dong, Seo-gu, Incheon-si, Korea, 16 December 2014, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787892, 3 inds, artificial irrigation canal, Geomam-dong, Seo-gu, Incheon-si, Korea, 4 October 2014, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787894, 2 inds., artificial irrigation canal, Geomam-dong, Seo-gu, Incheon-si, Korea, 17 October 2012, collected by Robert Blakemore, fixed in 80% ethanol. NIBRIV0000787891, 3 inds., lower part of Gongneungcheon stream, Paju-si, Gyeonggi-do, Korea, 5 October 2014, collected by Taeseo Park and Masanori Sato, fixed in 80% ethanol. NIBRIV0000783707, 4 inds., lower part of Munsancheon stream, Paju-si, Gyeonggi-do, Korea (37°51′28″N, 126°46′35″E), 18 April 2012, collected by Daeseong An, fixed in 70% ethanol.

Variation in paragnath number

Paragnath numbers are summarized in Table 21.

Habitats

Muddy area of river mouth.

Distribution

Korea (Fig. 36).

Molecular data

The COI sequences obtained from nine individuals (Table 4, Appendix 2).

Remarks

Sato and Nakashima (2003) have revised species complex of Asian *Hediste* species. They redescribed *H. japonica* based on newly collected specimens, rediscovered type material, and described two new species: *H. atoka* and *H. diadroma*. These three species are very similar to one another in morphology. Especially, *H. atoka* and *H. diadroma* cannot be distinguished from each other in sexually immature specimens. Later, Tosuji and Sato (2012) have suggested a reliable molecular method for precise identification among *Hediste* species using 16S rRNA sequence.

In the present study, four taxa belonging to genus *Hediste* are subjected to COI sequence comparison based on specimens from Korea and Japan. Among them, three clades are identical to topotype sequences of *H. atoka*, *H. diadroma*, and *H. japonica* respectively. However, one clade is clearly separated from other clades that are previously known species. Therefore, one unknown species is detected and designated as *Hediste* sp. (Fig. 37, Table 20)

According to Sato and Nakashima (2003) and Tosuji and Sato (2012), distribution of these three Asian *Hediste* species are as follows: (1) *H. atoka* is distributed in Japan and Korea (western coast), (2) *H. diadroma* is distributed in Japan and China (north eastern coast), and (3) *H. japonica* is distributed in Japan and Korea (western coast). However, distribution of *H. diadroma* from Korean waters is newly added from this study (Fig. 33).

Table 20. Mean pairwise genetic distances (K2P distance) based on COI sequences among four *Hediste* species.

Species	*H. atoka*	*H. diadroma*	*H. japonica*	*H.* sp.
H. atoka (n=37)	0.018	0.139	0.166	0.123
H. diadroma (n=8)	0.139	0.014	0.169	0.154
H. japonica (n=11)	0.166	0.169	0.007	0.193
H. sp. (n=9)	0.123	0.154	0.193	0.000

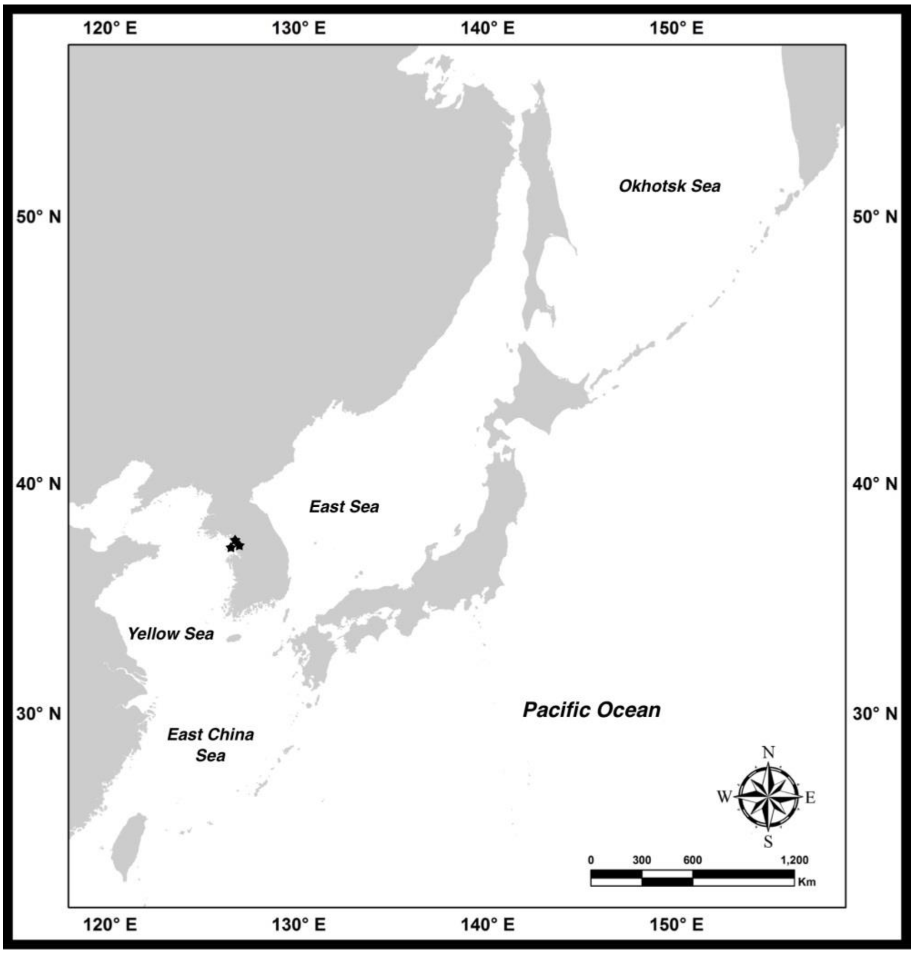

Fig. 36. Distribution of *Hediste* sp. in Northeast Asia based on the present study (★).

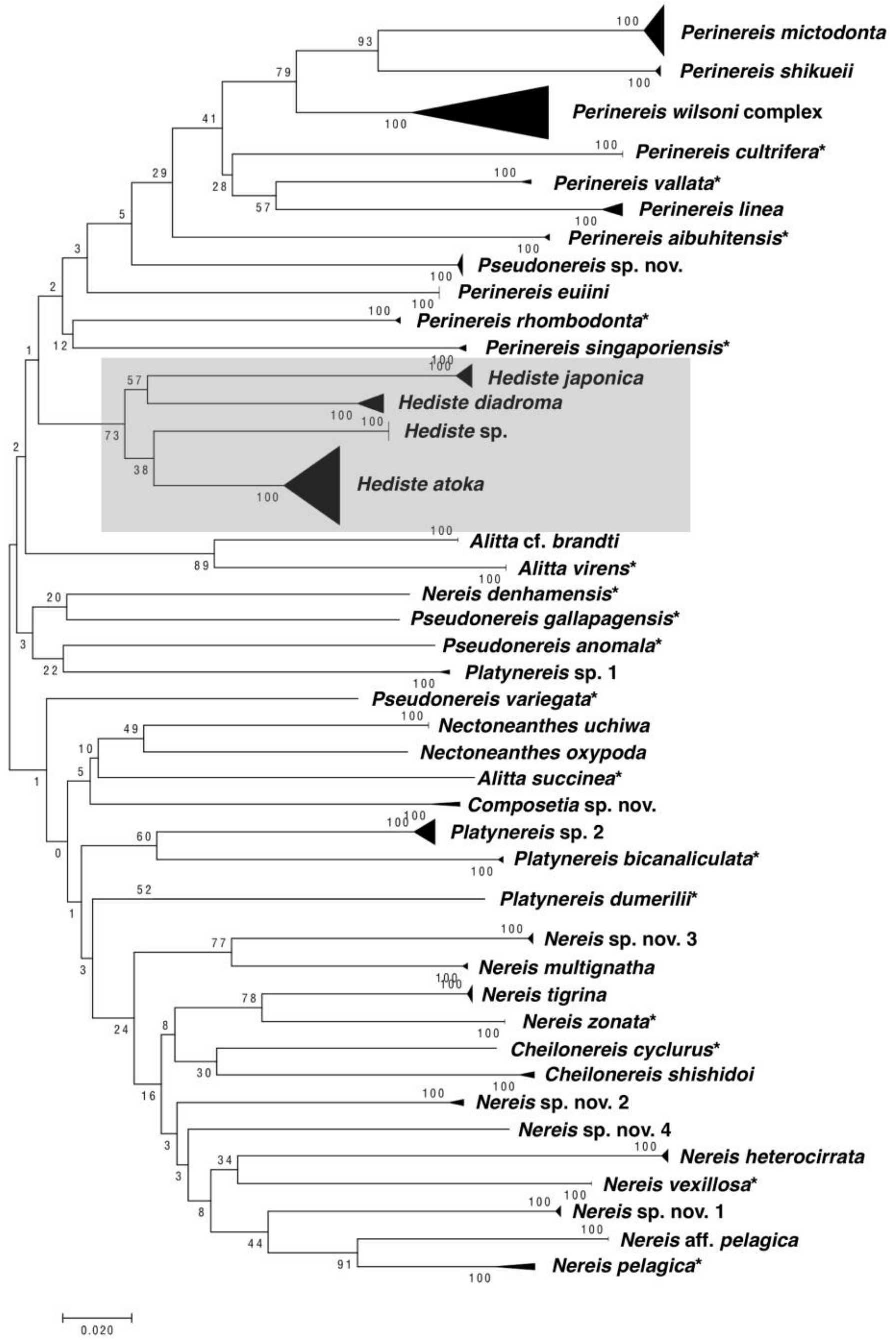

Fig. 37. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray box represents the difference among four *Hediste* species.

Table 21. Variation in paragnath numbers in area I to VIII on proboscis of *Hediste* sp. Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Locality	I	II(L)	II(R)	II (Total)	III	IV(L)	IV(R)	IV (Total)	V	VI(L)	VI(R)	VI (Total)	VII–VIII
Korea (n=11) (Gyesan-dong, Incheon-si)	1–8 (2.2±2)	2–10 (7±2.4)	7–12 (9.6±1.6)	12–22 (16.5±2.8)	24–39 (32.6±5.6)	3–18 (13±4)	5–17 (12.1±3.6)	8–35 (25.1±7.3)	0	4–7 (4.8±1)	3–6 (4.7±0.8)	7–12 (9.6±1.4)	19–39 (26±5.1)
Korea (n=3) (Gongneungcheon stream, Paju-si)	1–2 (1.3±0.6)	8–9 (8.7±0.6)	6–11 (8.3±2.5)	14–20 (17±3)	32–34 (33.3±1.2)	11–20 (14.7±4.7)	11–19 (14.7±4)	22–39 (29.3±8.7)	0	3–6 (5±1.7)	4–6 (5±1)	7–12 (10±2.6)	24–27 (25.3±1.5)
Korea (n=4) (Munsancheon stream, Paju-si)	1–5 (2.3±1.9)	8–14 (9.8±2.9)	6–12 (8.5±2.6)	14–26 (18.3±5.4)	29–57 (39.3±13)	12–15 (14±1.4)	12–19 (15±2.9)	24–34 (29±4.2)	0	4–5 (4.5±0.6)	4–5 (4.5±0.6)	8–10 (9±0.8)	17–44 (26.3±12.1)

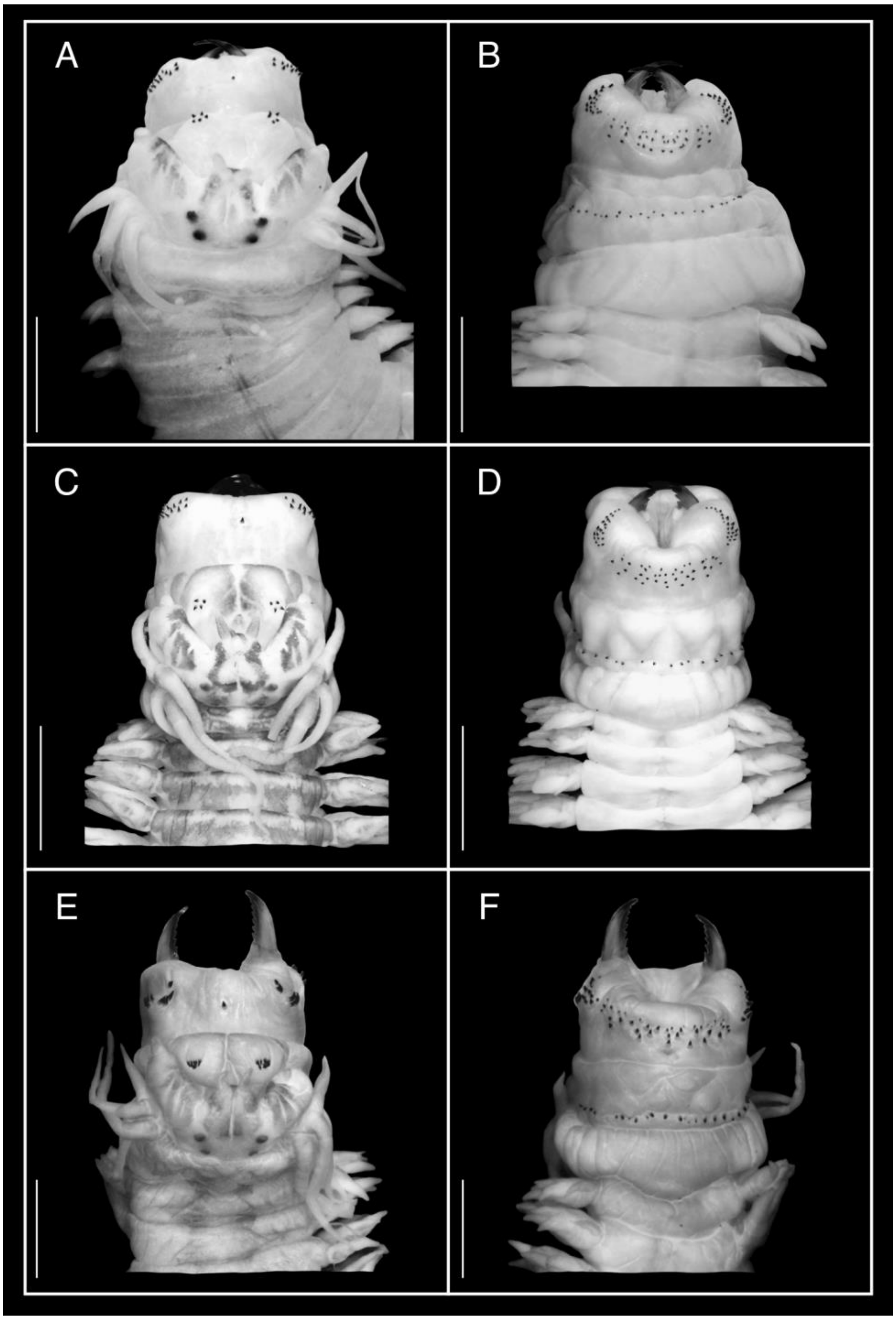

Fig. 38. Dorsal and ventral views of everted proboscis of three *Hediste* species. (A, B) *H. atoka* Sato and Nakashima, 2003 (NIBRIV0000781336). (C, D) *H. diadroma* Sato and Nakashima, 2003 (NIBRIV0000787274). (E, F) *H. japonica* (Izuka, 1908) (NIBRIV0000244195). Scale bars, 2 mm.

Genus *Nectoneanthes* Imajima, 1972

Nectoneanthes Imajima, 1972: 113; Fauchald, 1977: 89–90; Wu et al., 1985: 161; Khlebovich, 1996: 114.

Type species: *Nereis* (*Alitta*) *oxypoda* Marenzeller, 1879.

Diagnosis

Prostomium with entire anterior margin, one pair of antennae, one pair of palps, two pairs of eyes. Eversible proboscis with conical paragnaths on both maxillary and oral rings. Four pairs of tentacular cirri. Parapodia of first two chaetigers sub-biramous, all following parapodia biramous. Sub-biramous parapodia with thin notoacicula and thick neuroacicula. Notopodia consisting of dorsal cirrus, dorsal ligule, prechaetal lobe and ventral ligule in biramous parapodia; notopodial dorsal ligule expanded with prominent ovoid lobe developing above dorsal cirrus in middle and posterior parapodia even in atokes. Neuropodia consisting of inferior lobe, postchaetal lobe, ventral ligule and ventral cirrus throughout; all neuropodial lobes and ligule slender and conical. Notochaetae homogomph or sesquigomph spinigers. Neurochaetae in both upper and lower fascicles consisting of homogomph or sesquigomph spinigers and heterogomph spinigers. Falcigers absent except for neurochaetae in juveniles. (after Sato, 2013).

8. *Nectoneanthes oxypoda* (Marenzeller, 1879) (Figs. 39, 40, 41A, B)

Nereis (*Alitta*) *oxypoda* Marenzeller, 1879: 120–122, pl. 2, fig. 3.

Nereis (*Neanthes*) *oxypoda*: Fauvel, 1932: 22; Treadwell, 1936: 268; Uschakov, 1965:187–188, fig. 63E.

Nereis oxypoda: Izuka, 1912: 171–173, pl. 18, figs. 8–11 (in part); Mori et al., 1932: 3, pl. 1, fig. 2, pl. 3, figs. 1–6 (in part); Monro, 1934: 362–363 (in part, specimen collected by Chen); 1938: 614–617, figs. 1–5.

Neanthes oxypoda: Hutchings and Murray, 1984: 37–39, fig. 12.

Nectoneanthes oxypoda: Imajima, 1972: 116–117, figs. 36 a–d (in part, epitokes); Imajima, 1996: 145, fig. 116' (in part, epitokes); Sato, 2013: 4–24, figs. 1, 2, 3 A–C, 4 A, 5–8.

Nereis alatopalpis Wesenberg-Lund, 1949: 281–283, figs. 15–17.

Nectoneanthes alatopalpis: Wu et al., 1985: 168–169, fig. 94; Khlebovich, 1996: 115.

Nectoneanthes donghaiensis He, 1987: 346–349, figs. 1–7.

Nereis ijimai Izuka, 1912: 174–176, pl. 2, fig.1, pl. 19, figs. 1–9; Horst, 1918: 258.

Neanthes ijimai: Imajima and Hartman, 1964: 144–145.

Nectoneanthes ijimai: Imajima, 1972: 117–119; Imajima, 1996: 143, fig. 115; Wu et al., 1985: 161–163, fig. 90.

Nectoneanthes latipoda Paik, 1973: 81–84, figs. 1a–j, 2; Imajima, 1996: 146–147, figs. 117–117'; Khlebovich, 1996: 116, pl. XXIII; Nishi et al., 1998: 199; Lee et al., 2003: 191; Choi et al., 2005: 387; Yamanishi and Sato, 2007: appendix 20.

Neanthes latipoda: Wilson, 1988: 9.

Nereis (*Nereis*) *legeri* Gravier and Dantan, 1934: 57–61, figs. 17–21.

Nectoneanthes multignatha Wu, Sun and Yang, 1981: 163–164, fig. 91.

Neanthes multignatha: Wilson, 1988: 9.

Nereis singularis Wesenberg-Lund, 1949: 278–281, figs. 13–14.

Nectoneanthes singularis: Khlebovich, 1996: 115.

Neanthes succinea: Wilson, 1984: 218–221 (in part, 9 specimens from NSW and 5 specimens from WA, Australia); 1988: 5–7 (in part).

Materials examined

Non-type materials

NIBRIV0000217911, 2 inds., subtidal mud flat, Yeongjongdo Is., Jung-gu, Incheon-si, Korea, May 1991, collected by Jae-Sang Hong. NIBRIV0000024426, 2 inds., Suncheon-si, Jeollanam-do, Korea, 22 May 1998, collected by Seong-Gyu Yun. NIBRIV0000207965, 1 ind., Yeongjongdo Is., Jung-gu, Incheon-si, Korea, January 1994, collected by Jae-Sang Hong. NIBRIV0000024425, 1 ind., Geomundo Is., Samsan-myeon, Yeosu-si, Jeollanam-do, Korea, 24 May 2002, collected by Jong-Wui Lee and Su-Yeon Seo. NIBRIV0000787923, 1 ind., Chwido Is., Ochui-ri, Podu-myeon, Goheung-gun, Jeollanam-do, Korea, 28 April 2013, collected by Seong-Hyun Kim, Sun-Sang Hong and Kyung-Sook Lee.

Diagnosis

Paragnaths in area VII–VIII arranged in distal single transverse row of large paragnaths and proximal irregular one or two rows of large and small paragnaths, extending to lateral and often dorsal surface near area VI in oral ring, not reaching group V. Relatively small number of paragnaths in area II, III and IV in maxillary ring (modified from Sato, 2013).

Description of atokes

Body stout anteriorly, gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Colour in preserved specimens whitish cream with brownish pigmentation in anterior dorsum.

Prostomium pyriform, slightly wider than long, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with large palpophores and short round palpostyles. Two pairs of eyes arranged trapezoidally; anterior pair reniform, slightly smaller; posterior pair circular form and larger; gap of anterior pair wider than posterior pair. Dark brown pigmentation present on dorsal surface of prostomium (Fig. 40A, B; 41A, B).

Peristomium slightly longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetigers 3–5 (Fig. 40A, B; 41A, B).

Proboscis with pair of dark brown amber jaws, each with 9–12 teeth of serrated inner margin. Conical paragnaths present on both maxillary and oral rings. Paragnath numbers and arrangements as follows: area I, 0–5 in longitudinal row; area II, 11–20 on left and 14–26 on right, arranged in 3–4 arched rows; area III, 1–11 in rhomboidal patch; area IV, 13–19 on left and 11–20 on right in oblique cluster; area V, 0–3 in longitudinal arrangement; area VI, 7–16 on right and 8–14 on left in circular cluster; area VII–VIII, 61–85 arranged in distal single transverse row of large paragnaths and proximal irregular single row of large and small paragnaths, extending to lateral and often dorsal surface near group VI, not reaching group V (Table 22; Fig. 40A, B).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia with notoacicula and with reduced notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of inferior lobe, postchaetal lobe, ventral ligule, and ventral cirrus (Fig. 40C, D).

Notopodia consisting of dorsal cirrus, dorsal ligule, prechaetal lobe and ventral ligule in biramous parapodia. Notopodial dorsal ligule subconical in anterior parapodia, expanded to large triangular with prominent ovoid lobe developing above dorsal cirrus in middle and posterior parapodia; first ovoid lobe above dorsal cirrus appearing at chaetigers 13–16; notopodial dorsal ligule most expanded in middle parapodia, gradually diminishing in size in posterior parapodia (Fig. 40E–L). Notopodial prechaetal lobe and notopodial ventral ligule slender with tapering tip throughout; notopodial prechaetal lobe subequal to notopodial ventral ligule in anterior and middle parapodia, reduced in size in posteriormost parapodia. Dorsal cirri slender, tapering. (Fig. 40E–L).

Neuropodia consisting of inferior lobe, postchaetal lobe, ventral ligule and ventral cirrus throughout; all lobes and ligules slender with tapering tip throughout, of similar length; ventral cirri slender with tapering tip (Fig. 40E–L).

Notochaetae all homogomph or sesquigomph spinigers with finely serrated long blades (Fig. 40N). Upper neurochaetae consisting of heterogomph spinigers with short serrated blades at superior-anterior position, and homogomph or sesquigomph spinigers with long serrated blades (Fig. 40O) at inferior-posterior position. Lower neurochaetae consisting of homogomph or sesquigomph spinigers with long serrated blades at superior-posterior position, and heterogomph spinigers with short serrated blades at inferior-anterior position (Fig. 40M).

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri (description modified from Sato, 2013).

Variation in paragnath number

Paragnath numbers in *Nectoneanthes oxypoda* are summarized in Table 22.

Habitats

Sandy or muddy bottom in intertidal or subtidal zones.

Distribution

Type locality: Yokohama, Japan. Asian Pacific coasts (China, Korea, and Japan) north to Far East Russia and south to Vietnam, Persian Gulf, Southern Australia (Fig. 39).

Molecular data

The COI sequence obtained from one individual (Table 4, Appendix 2).

Remarks

See remarks part of *Nectoneanthes uchiwa* on page 125.

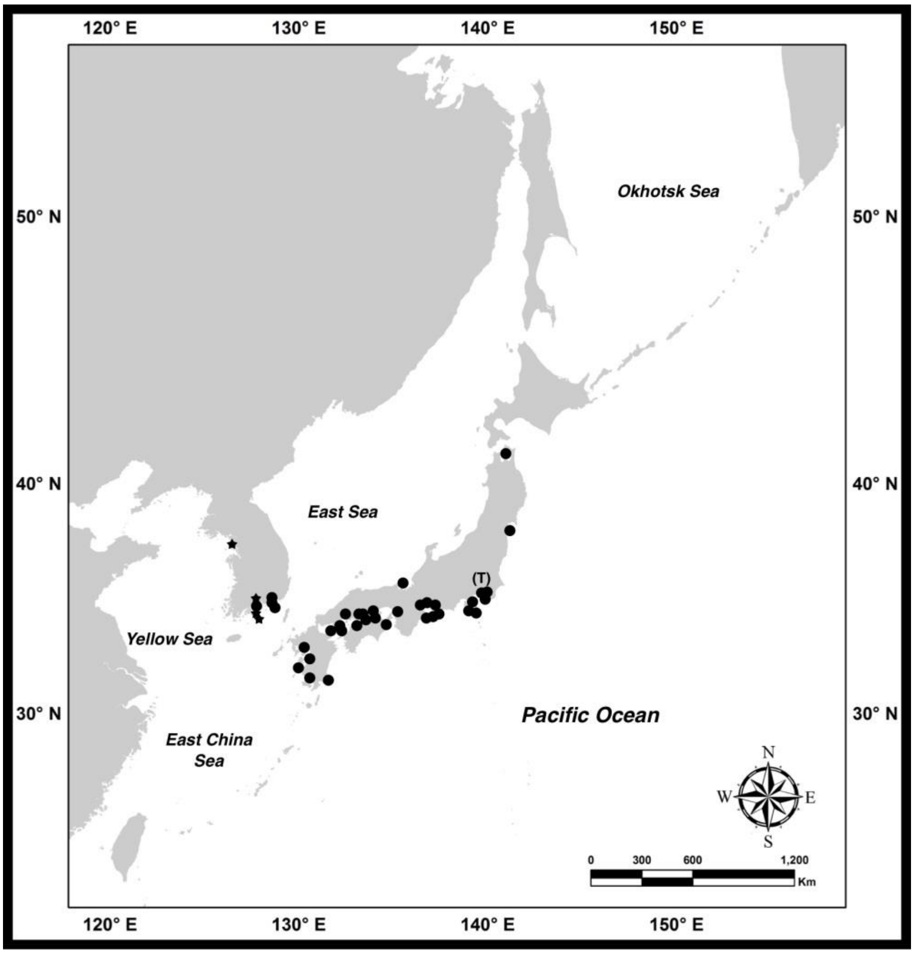

Fig. 39. Distribution of *Nectoneanthes oxypoda* (Marenzeller, 1879) in Northeast Asia based on the present study (★) and the literature. (●) Sato (2013). (T) Type locality.

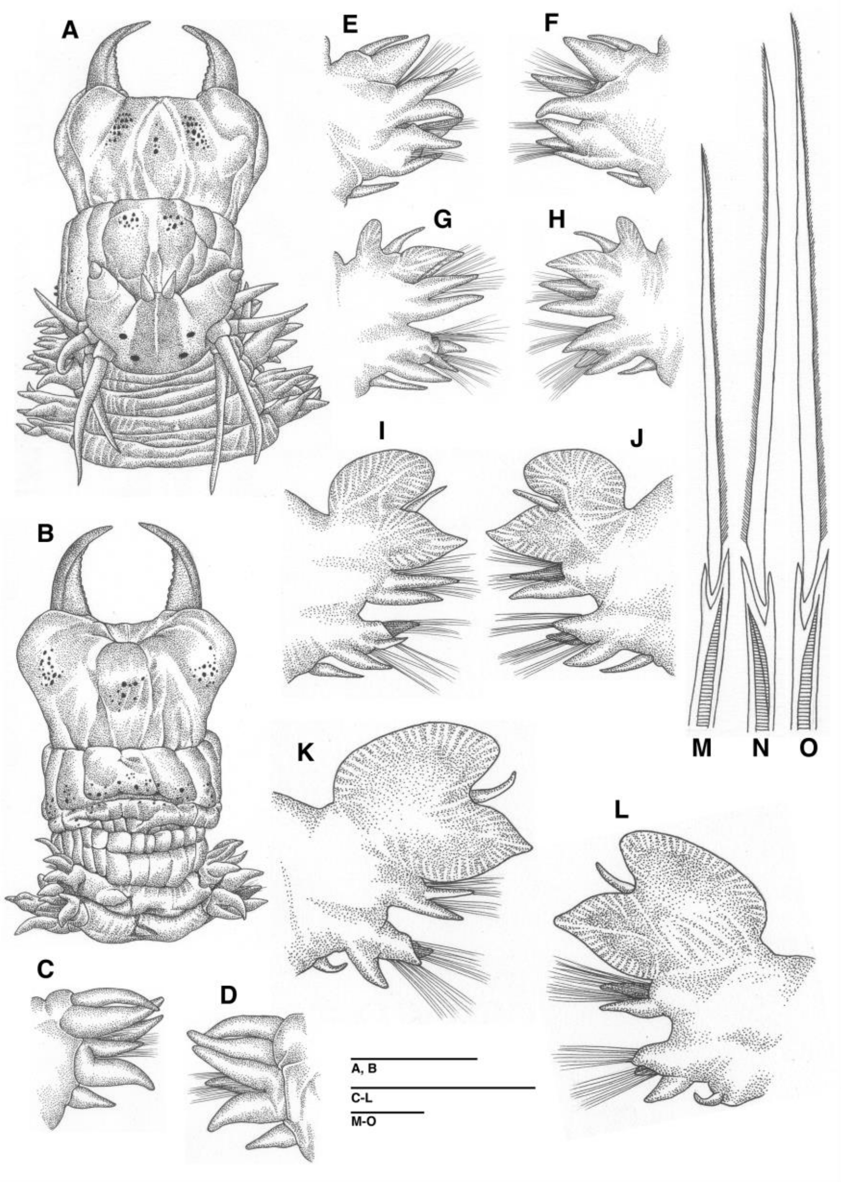

Fig. 40. *Nectoneanthes oxypoda* (Marenzeller, 1879), NIBRIV0000787923. (A, B) Dorsal and ventral views of anterior end with the everted proboscis. (C, D) Anterior and posterior views of parapodium 1. (E, F) Anterior and posterior views of parapodium 10. (G, H) Anterior and posterior views of parapodium 17. (I, J) Anterior and posterior views of parapodium 32. (K, L) Anterior and posterior views of parapodium 70. (M) Heterogomph spiniger from lower neurochaetae in parapodium 88. (N) Sesquigomph spiniger from notochaetae in parapodium 25. (O) Sesquigomph spiniger from upper neurochaetae in parapodium 25. Scale bars: 5 mm in (A, B), 2 mm in (C–L), 0.02 mm in (M–O).

Table 22. Variation in paragnath numbers in area I to VI on proboscis of *Nectoneanthes oxypoda* (Marenzeller, 1879). Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Locality	I	II(L)	II(R)	III	IV(L)	IV(R)	V	VI(L)	VI(R)
Korea (n=7) (Present study)	0–5 (2±1.5)	11–20 (16.6±3.6)	14–26 (17.3±4)	1–11 (4.2±3.4)	13–19 (15.9±2.1)	11–20 (15.1±3.2)	0–3 (1.1±0.9)	7–16 (11.9±3.4)	8–14 (10.9±2.5)
Korea (n=12) (Paik, 1973 as *N. latipoda*)	2–6	13–24		3–11	9–22		1	8–15	
Japan (Sato, 2013)	0–4 (n=42)	(21–44)* (n=13)		0–9 (n=62)	(21–41)* (n=15)		0–5 (n=108)	(13–28)* (n=58)	
China (Wu et al., 1985 as *N. multignatha*)	1–2	11–14		2–3	14–16		1	6–7	

*Total number on right and left sides of proboscis.

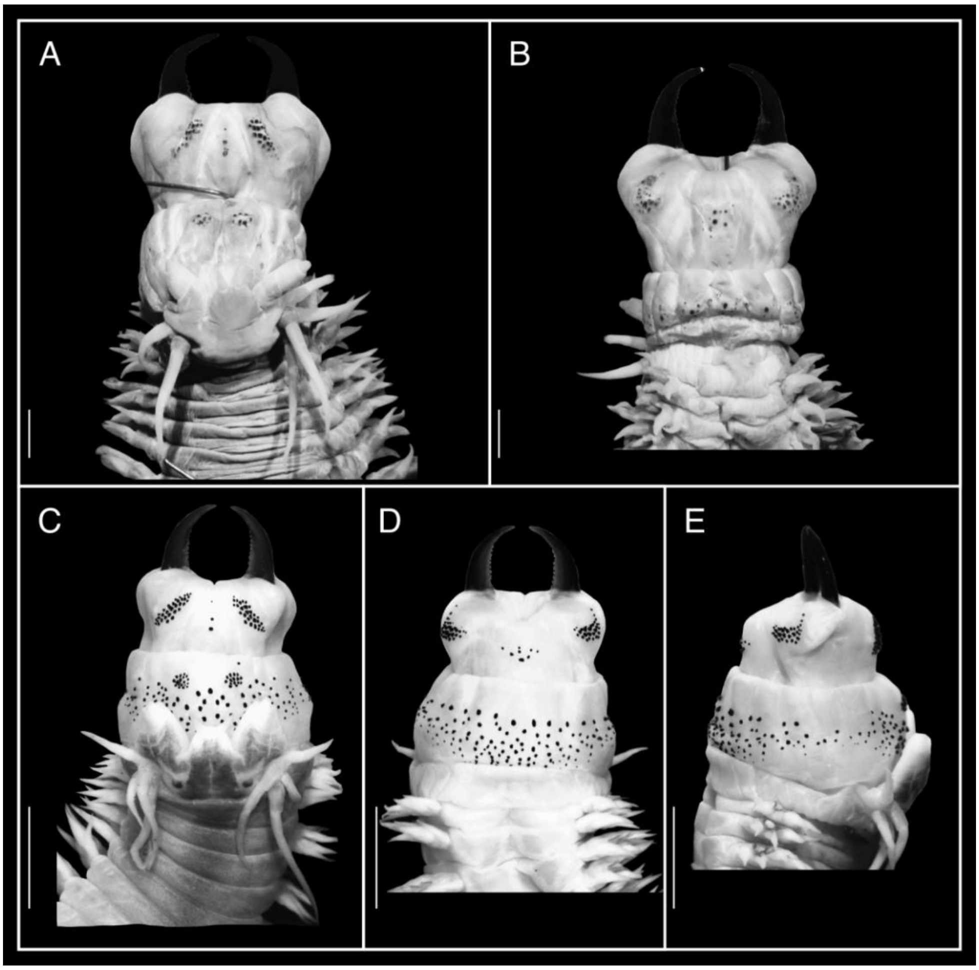

Fig. 41. Dorsal and ventral views of everted proboscis of three *Nectoneanthes oxypoda* (Marenzeller, 1879) and *N. uchiwa* Sato, 2013. (A, B) *N. oxypoda* (NIBRIV0000787923). (C, D) *N. uchiwa* (NIBRIV0000787900). (E) Lateral view of proboscis of *N. uchiwa* (NIBRIV0000787900). Scale bars, 2 mm.

9. *Nectoneanthes uchiwa* Sato, 2013 (Figs. 41, 42–44)

Nectoneanthes uchiwa Sato, 2013: 24–34, figs. 4A, 9–14.

Nereis oxypoda Izuka, 1912: 171–173, pl. 18, figs. 8–11 (in part); Mori et al., 1932: 3, pl. 1, fig. 2, pl. 3, figs. 1–6 (in part); Okuda, 1933: 247, pl. 13, figs. fpl. 1, fig. 2, pl. 3, figs. 1–6h; Monro, 1934: 362–363 (in part).

Nereis (*Neanthes*) *oxypoda*: Khlebovich, 1963: 55.

Neanthes oxypoda: Imajima and Hartman, 1964: 145.

Neanthes (*Nectoneanthes*) *oxypoda* var.: Wilson, 1984: 220.

Neanthes sp.: Wilson, 1988: 7–8.

Nectoneanthes oxypoda: Imajima, 1972: 113–118, figs. 35b, c (in part, atokes); Paik, 1972: 135, fig. 4; Paik, 1973: 82–84, figs. 1k–l, 2; Wu et al., 1985: 164–167, figs. 92–93; Yang and Sun, 1988: 39, figs. 8A–D; Imajima, 1996: 144–145, figs. 116 b, c (in part, atokes); Khlebovich, 1996: 115–116, pl. 22; Lee et al., 2003: 189–190; Yamanishi and Sato, 2007: 183.

Materials examined

Non-type materials

NIBRIV0000787900, 6 inds., intertidal mud flat, Mongsanpo Harbor, Mongsan-ri, Nam-myeon, Taean-gun, Chungcheongnam-do, Korea (36°40′19″N, 126°16′26″E), 11 April 2013, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000273972, 2 inds., Jungsan-dong, Jung-gu, Incheon-si, Korea (37°29′41.78″N, 126°35′35.59″E), 21 March 2012, collected by Soon-Young Wang. NIBRIV0000273978, 1 ind., Gunsan-si, Jeollabuk-do, Korea (35°59′33″N, 126°42′56.4″E), 11 April 2011, collected by Seok-Hyun Yoon. NIBRIV0000273970, 1 ind.; NIBRIV0000273969, 1 ind., Yeodong-ri, Yulchon-myeon, Yeosu-si, Jeollanam-do, Korea (34°52′53.42″N, 127°36′19.94″E), 23 February 2012, collected by Soon-Young Wang. NIBRIV0000024424, 1 ind., Seeodo Is., Wonchang-dong, Seo-gu, Incheon-si, Korea, 8 October 1999, collected by Eun Ye and In-Soon Seo.

NIBRIV0000243465, 1 ind., Gwangyangman bay, Gwangyang-eup, Gwangyang-si, Jeollanam-do, Korea, 7 April 1997, collected by Jae-Sang Hong. NIBRIV0000205279, 1 ind., Gwangyangman bay, Gwangyang-si, Jeollanam-do, Korea, 20 April 1996, collected by Jae-Sang Hong. NIBRIV0000273981, 1 ind., Sora-myeon, Yeosu-si, Jeollanam-do, Korea, 10 May 2012, collected by Byung-Mi Choi and Jae-Seong Yun. NIBRIV0000212993, 2 inds., Intertidal flat, Deokgyo-dong, Jung-gu, Incheon-si, Korea, 24 January 2000, collected by Jae-Sang Hong. NIBRIV0000208088, 1 ind., Cheokcheon, Baeseok-dong, Seo-gu, Incheon-si, Korea, September, 1990, Jae-Sang Hong. NIBRIV0000273982, 1 ind., Iwon-myeon, Taean-gun, Chungcheongnam-do, Korea (34°54′56.87″N, 129°15′29.59″E), 22 February 2012, collected by Dong-Woon Hwang. NIBRIV0000273980, 1 ind., Sora-myeon, Yeosu-si, Jeollanam-do, Korea (34°47′37.32″N, 127°31′58.05″E), 10 May 2012, collected by Byoung-Mi Choi and Jae-Seong Yun.

Diagnosis

Broad continuous band of many paragnaths (more than 200) present in dorsal and ventral areas of oral ring of proboscis, covering areas V and VII–VIII, except for area VI remaining in compact clusters separated from other paragnaths. Relatively larger number of paragnaths in area II (24–44 on each side), III (6–21) and IV (19–47) on each side) in maxillary ring of proboscis than *N. oxypoda* (modified from Sato, 2013).

Description of atokes

Body stout anteriorly, gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum with longitudinal brown pigmentation on central, with whitish brown pigmentation on both sides in live individuals, with pale pigmentation of brownish cream color in preserved ones.

Prostomium pyriform, slightly wider than long, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with large palpophores and short round palpostyles.

Two pairs of eyes arranged trapezoidally; anterior pair reniform, slightly smaller; posterior pair circular form and larger; gap of anterior pair wider than posterior pair. Dark brown pigmentation present on dorsal surface of prostomium (Figs. 41C, D; 43A, B).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 3–5 (Figs. 41C, D; 43A, B).

Proboscis with pair of brown amber jaws, each with 9–12 teeth of serrated inner margin. Conical paragnaths present on both maxillary and oral rings. Paragnath numbers and arrangements as follows: area I, 3–5 in longitudinal row; area II, 24–44 on left and 25–40 on right, arranged in 3–4 arched rows; area III, 6–21 in rhomboidal patch; area IV, 21–45 on left and 19–47 on right in oblique cluster; continuous broad transverse band of large number of paragnath (more than 200) present on both dorsal and ventral areas of oral ring, through areas V to VII–VIII, except VI; area VI, 9–18 on left and 11–17 on right in circular cluster (Figs. 41C–E; 43).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia with notoacicula and with reduced notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of inferior lobe, postchaetal lobe, ventral ligule, and ventral cirrus (Fig. 43D).

Notopodia consisting of dorsal cirrus, dorsal ligule, prechaetal lobe and ventral ligule in biramous parapodia. Notopodial ligule slender with tapering tip in anterior parapodia, expanded to large triangular with prominent ovoid lobe developing above dorsal cirrus in middle and posterior parapodia; first ovoid lobe above dorsal cirrus appearing at chaetigers 13–15; notopodial dorsal ligule most expanded in middle parapodia, gradually reduced in size in posterior parapodia (Fig. 43E–J). Notopodial prechaetal lobe and notopodial ventral ligule slender with tapering tip throughout; notopodial prechaetal lobe subequal to notopodial ventral ligule throughout. Dorsal cirri slender, tapering, slightly shorter than notopodial dorsal ligule in anterior parapodia, about half length to tip of notopodial dorsal ligule in middle and posterior parapodia (Fig. 43E–J).

Neuropodia consisting of inferior lobe, postchaetal lobe, ventral ligule and ventral cirrus throughout; all neuropodial lobes and ligule slender with tapering tip in anterior parapodia, changed to triangular and gradually diminishing in size in posterior parapodia, prechaetal lobe slightly longer than inferior lobe throughout, ventral ligule subequal to inferior lobe throughout. Ventral cirrus slender with tapering tip (Fig. 43E–J).

Notochaetae all homogomph or sesquigomph spinigers; blades long with finely serrated edge (Fig. 43M). Upper neurochaetae consisting of heterogomph spinigers with short serrated blades at superior-anterior position, and homogomph or sesquigomph spinigers with long serrated blades (Fig. 43L) at inferior-posterior position. Lower neurochaetae consisting of homogomph or sesquigomph spinigers with long serrated blades at superior-posterior position, and heterogomph spinigers with short serrated blades at inferior-anterior position (Fig. 43K).

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri (description modified from Sato, 2013).

Variation in paragnath number

Paragnath numbers in *Nectoneanthes uchiwa* are summarized in Table 23.

Habitats

Muddy bottom in intertidal or shallow subtidal zones.

Distribution

Type locality: Kojima Bay in Seto Inland Sea, Okayama Prefecture, Japan. Eastern Asian coast (China, Korea, and Japan) (Fig. 42).

Molecular data

The COI sequences obtained from three individuals (Table 2, Appendix 4).

Remarks

The genus *Nectoneanthes* was erected by Imajima (1972). Wilson (1988) regarded *Nectoneanthes oxypoda* as a synonym of *Neanthes succinea* (Leuckart, 1847). Thereafter, Bakken and Wilson (2005) transferred *Neanthes succinea* to genus *Alitta* Kinberg, 1865. As a result, genus *Nectoneanthes* was regarded as a junior synonym of genus *Alitta*.

Recently, Sato (2013) revised all nominal species previously known as *Nectoneanthes* (i.e. *N. alatopalsis*, *N. donghaiensis*, *N. latipoda*, *N. multignatha*, *N. oxypoda*, *N. singularis*). He demonstrated that the genus *Nectoneanthes* was valid, neither a junior synonym of *Neanthes* nor *Alitta*. He also demonstrated that most nominal species previously known as *Nectoneanthes* were junior synonyms of *N. oxypoda* except *N. oxypoda sensu* Imajima, 1972 which was described as a new species of *N. uchiwa* in the same paper.

Morphological characteristics of the present specimens collected from Korea (Yellow Sea, sourthern coast of Korea) well agreed with those of *N. oxypoda* and *N. uchiwa*. These two species can be distinguished by the presence of broad band of many paragnaths in oral ring and the number of paragnath in maxillary ring. There is a continuous broad band of many paragnaths covering area V and VII–VIII in *N. uchiwa* (Figs. 41C–E, 43A, B). However, paragnaths on area V is separated from areas VII–VIII in *N. oxypoda* (Figs. 40A, B; 41A, B). *Nectoneanthes uchiwa* also has larger numbers of paragnaths in maxillary ring than *N. oxypoda* (Table 24).

DNA sequence comparisons of COI also support results of morphological comparison of Sato (2013) and the present study. DNA sequences of *N. oxypoda* and *N. uchiwa* markedly differed from one another (mean p-distance: 0.159) (Fig. 44, Table 25).

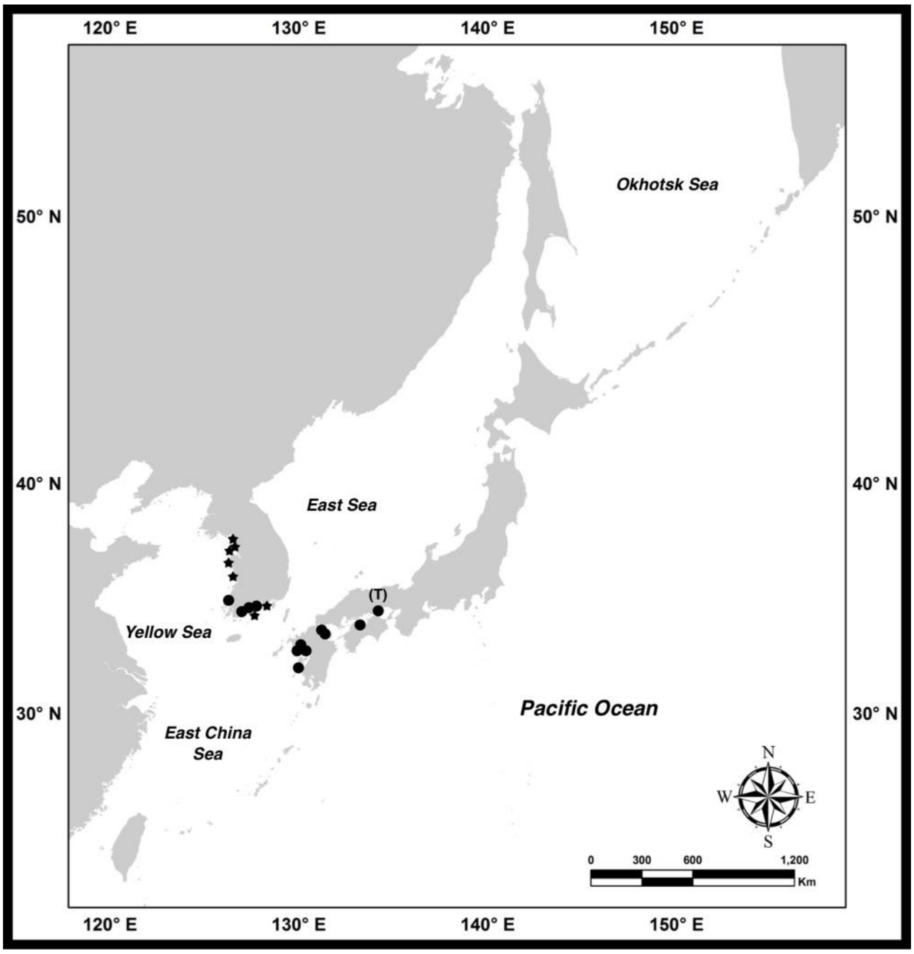

Fig. 42. Distribution of *Nectoneanthes uchiwa* Sato, 2013 in Northeast Asia based on the present study (★) and the literature. (●) Sato (2013). (T) Type locality.

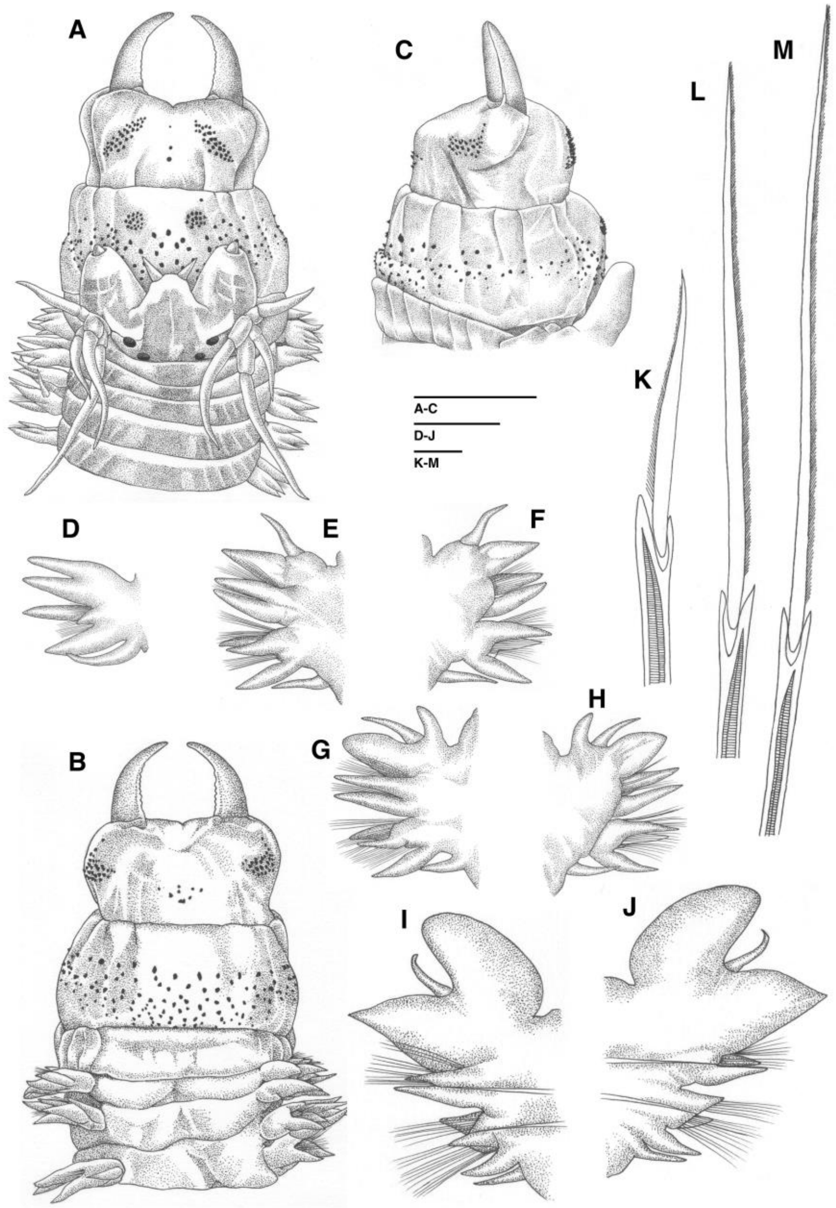

Fig. 43. *Nectoneanthes uchiwa* Sato, 2013, (A–M) NIBRIV0000787900. (A–C) Dorsal, ventral, and lateral views of anterior end with the everted proboscis. (D) Anterior view of parapodium 1 (E–J) Anterior and posterior views of parapodium 10 (E, F); 15 (G, H); 55 (I, J). (K) Heterogomph spiniger from neuropodial lower fascicle in parapodium 15. (L) Sesquigomph spiniger from neuropodial upper fascicle in parapodium 15. (M) Homogomph spiniger from notopodial fascicle in parapodium 15. Scale bars: 2 mm in (A–C); 1 mm in (D–J); 0.02 mm in (K–M).

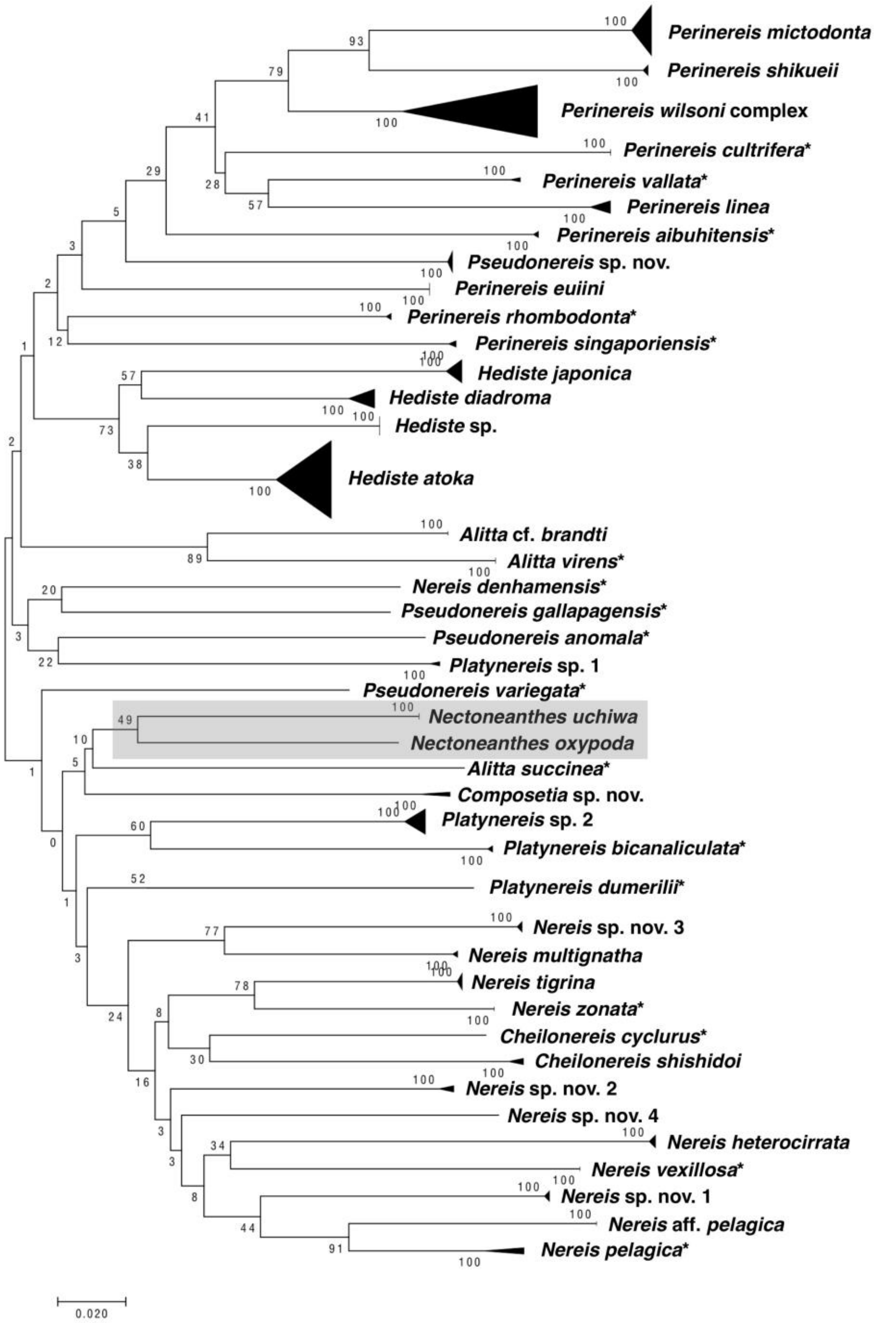

Fig. 44. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray box represents the difference between *Nectoneanthes uchiwa* Sato, 2013 and *N. oxypoda* (Marenzeller, 1879).

Table 23. Variation in paragnath numbers in area I to IV and VI on proboscis of *Nectoneanthes uchiwa* Sato, 2013. Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Locality	I	II(L)	II(R)	III	IV(L)	IV(R)	VI(L)	VI(R)
Korea (n=20) (Present study)	3–5 (3.9±0.6)	24–44 (30.6±4.8)	25–40 (31.4±3.7)	6–21 (12.8±4.9)	21–45 (31±6.2)	19–47 (31.1±6.6)	9–18 (13.4±2.2)	11–17 (13.9±1.9)
Korea (n=47) (Paik, 1973 as *N. oxypoda*)	2–6	19–43		10–34	26–49		9–18	
Japan (Sato, 2013)	1–4 (n=26)	(28–58)* (n=16)		3–17 (n=29)	(35–68)* (n=14)		(15–27)* (n=18)	
China (n=4) (Yellow Sea and Hainan Is., (Khlebovich, 1996 as *N. oxypoda*)	1–5	22–32		5–20	24–35		8–15	

*Total number on right and left sides of proboscis.

Table 24. Comparison of paragnath number arrangement of two *Nectoneanthes* species.

Species (Locality and reference)	Range of paragnath number					
	I	II*	III	IV*	V	VI*
N. oxypoda (Korea, present study)	0–5	26–46	1–11	24–38	0–3	15–30
(Korea, Paik, 1973, as *N. latipoda*)	2–6	26–48	3–11	18–44	1	16–30
(Japan, Sato, 2013)	0–4	21–44	0–9	21–41	0–5	13–28
(Far East Russia, Khlebovich, 1996, as *N. latipoda*)	2	28–38	1–3	22–40	1–2	16–30
(China, Wu et al., 1985 as *N. multignatha*)	1–2	11–14	2–3	14–16	1	6–7
N. uchiwa (Korea, present study)	3–5	51–78	6–21	40–91	-	21–34
(Japan, Sato, 2013)	1–4	28–58	3–17	35–68	-	15–27
(Korea, Paik, 1973, as *N. oxypoda*)	2–6	38–86	10–34	52–98	-	18–36
(China, Khlebovich, 1996 as *N. oxypoda*)	1–5	44–64	5–20	48–70	-	16–30

*Total number on right and left sides of proboscis. Data of Paik (1973), Wu et al. (1985), Khlebovich (1996) were obtained from Sato (2013).

Table 25. Mean pairwise genetic distances (K2P distance) based on COI sequences between *Nectoneanthes oxypoda* (Marenzeller, 1879) and *N. uchiwa* Sato, 2013. n = individuals.

Species	*N. oxypoda*	*N. uchiwa*
N. oxypoda (n=1)	-	0.159
N. uchiwa (n=3)	0.159	0.000

Genus *Nereis* Linnaeus, 1758

Nereis Linnaeus, 1758: 654.

Type species: *Nereis pelagica* Linnaeus, 1758

Diagnosis

Prostomium with entire anterior margin, one pair of antennae, one pair of biarticulated palps with conical palpostyles, four pairs of tentacular cirri with distinct cirrophores. Eyes present or absent. One apodous anterior segment, greater than length of chaetiger 1. Maxillary ring of pharynx, conical paragnaths: areas I–III, present or absent; IV, present, smooth bar-like paragnaths present or absent. Oral ring: conical paragnaths present or absent. Notopodial dorsal ligule similar in size in anterior and posterior chaetigers or markedly reduced on posterior chaetigers. Notopodial prechaetal lobe present or absent, smaller than dorsal notopodial ligule on anterior chaetigers, usually reduced or absent posteriorly. Dorsal cirrus basally attached to dorsal notopodial ligule throughout all chaetigers, lacking basal cirrophore. Neuropodial postchaetal lobe present or absent. Notoaciculae absent from chaetigers 1 and 2. Notochaetae: homogomph spinigers, homogomph falcigers present. Upper neurochaetae: homogomph spinigers present, heterogomph falcigers on anterior chaetigers present or absent, on posterior chaetigers present. Lower neurochaetae: heterogomph spinigers present or absent, heterogomph falcigers present or absent (modified from Bakken and Wilson, 2005).

Remarks

The neuropodial postchaetal lobe has been considered absent in *Nereis* species according to recent phylogenetic analyses (Bakken and Wilson, 2005; Santos et al., 2005). However, some authors indicate its present (Read, 1980; Santos and Lana, 2003; Chambers and Garwood, 1992; Darbyshire, 2014; Conde-Vela and Salazar-Vallejo, 2015). Therefore, the author considered postchaetal lobes as absent or present.

10. *Nereis heterocirrata* Treadwell, 1931 (Figs. 45–48)

Nereis heterocirrata Treadwell, 1931: 1–2, text fig. 1a–c; Imajima and Hartman, 1964: 146–147; Wu, 1967: 62, fig. 7; Imajima, 1972: 125–129, figs. 41, 42, 51; 1996: 152–153, figs. 120a–k, 120’a–f; Paik, 1977: 187–189, fig. 23; 1978: 370–371, pl. 4; 1982: 788, pl. 13; 1984b: 148; Paik, 1989: 329–330, pls. 29, 30, figs. 72a (1, 2), b (1–3), text fig. 83.

Materials examined

Non-type materials

NIBRIV0000801029, 9 inds., associated with sessile organisms in intertidal rocky area, Youngilman Harbor, Pohang-si, Gyeongsangbuk-do Korea (36°4′5″N, 129°24′1″E), 28 February 2012, collected by Hang-Pil Lee and Dae-Seong An, fixed in 80% ethanol. NIBRIV0000801030, 1 ind., Yulim Beach, associated with sessile organisms in intertidal rocky area, Geomundo Is., Samsan-myeon, Yeosu-si, Jeollanam-do, Korea (34°2′24″N, 127°21′24″E), 25 April 2013, collected by Ye Eun, fixed in 80% ethanol. NIBRIV0000801031, 1 ind., associated with sessile organisms in intertidal rocky area, Wando-eup, Wando-gun, Jeollanam-do, Korea (34°18′14″N, 126°44′12″E), 3 September 2013, collected by Ye Eun, Taeseo Park, fixed in 80% ethanol. NIBRIV0000801032, 1 ind.; NIBRIV0000801034, 6 inds.; NIBRIV0000801041, 5 inds., 3 m in depth, associated with sessile organisms in subtidal rocky area, Geomundo Is., Yulchon boat deck, Seodo-ri, Samsan-myeon, Yeosu-si, Jeollanam-do, Korea (34°3′20″N, 127°17′36″E), 24 April 2013, collected by Taeseo Park, Sang-Hwi Lee, and Ye Eun, fixed in 80% ethanol. NIBRIV0000801033, 2 inds., associated with sessile organisms in intertidal rocky area, Gageodo Is., Gageodo Harbor, Heuksan-myeon, Sinan-gun, Jeollanam-do, Korea, 26 January 2012, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000801035, 1 ind., associated with sessile organisms in intertidal rock shore, Wando Is., Mangseok, Gunnae-ri, Wando-eup, Wando-gun, Jeollanam-do Korea (34°18′6″N, 126°46′12″E), 4 September 2013, collected by Ye Eun and Seul Yi, fixed in 80% ethanol. NIBRIV0000801036, 1 ind., under stone in intertidal area, Dolsando Is., Bangjukpo Beach, Jukpo-ri, Dolsan-eup, Yeosu-si, Jeollanam-do, Korea (34°37′49″N, 127°47′37″E), 17 March 2015, collected by Taeseo Park and Eun Ye, fixed in 80% ethanol. NIBRIV0000801037, 4 inds.; NIBRIV0000801039, 1 ind.; NIBRIV0000801040, 3 inds.; NIBRIV0000801045, 13 inds., intertidal rocky shore, Ulleungdo Is., Tongumi, Seo-myeon, Ulleung-gun, Gyeongsangbuk-do, Korea, 22 June 2014, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000801038, 1 ind.; NIBRIV0000801042, 18 inds., associated with sessile organisms in intertidal rocky area, Mongsanpo Harbor, Mongsan-ri, Nam-myeon, Taean-gun, Chungcheongnam-do, Korea (36°40′19″N, 126°16′26″E) 11 April 2013, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000801043, 3 inds., associated with sessile organisms in intertidal area, Gwangyang Bay, Namhae-gun, Gyeongsangnam-do., Korea (34°56′23″N, 127°49′55E) 21 February 2012, collected by Hang-Pil Lee and Dae-Seong An, fixed in 80% ethanol. NIBRIV0000801044, 5 inds., Hadong-gun, Gyeongsangnam-do, Korea (34°56′28″N, 127°52′11″E), 22 February 2012, collected by Pyung-Gang Lee and Hang-Pil Lee, fixed in 80% ethanol.

Diagnosis

Whitish green or brownish cream colored dorsum in live specimens. P-bar paragnath present in area IV toward jaw; paragnath usually absent in area V; minute paragnaths present in center of area VII–VIII. Ventral tentacular cirri thick with enlarged tentaculophores. Notopodial dorsal cirrus attached distally in posterior chaetigers. Noropodial prechaetal lobe absent throughout.

Description of atokes

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum whitish green or brownish cream color in live individuals, pale cream color in preserved ones.

Prostomium pyriform, slightly wider than long, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with palpophores and shorter thick-round palpostyles. Two pairs of eyes arranged trapezoidally; anterior pair slightly larger than posterior pair; gap of anterior pair slightly wider than posterior pair (Fig. 45A).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 4–6 (Figs. 45A, 46A); ventral tentacular cirri thick with enlarged tentaculophores.

Proboscis with pair of dark brown amber jaws, each with 4–5 teeth of serrated inner margin. Paragnaths present on both maxillary and oral rings usually except area V; paragnaths on oral ring larger than those on maxillary ones. Paragnath numbers and arrangements as follows: area I, 1–5 conical paragnaths in tandem; area II with conical paragnath, 8–40 on left, 9–38 on right, arranged in two to three crescentic rows; area III, 16–51 conical paragnaths in transverse band without lateral groups in four to five irregular transverse rows; area IV with conical and p-bar paragnath, 19–49 on left include 0–5 p-bars toward jaw, 18–50 on right include 0–5 p-bars toward jaw, arranged in curved cluster; area V, 0–4 conical paragnath, usually none; area VI, 2–6 conical paragnaths on each side; areas VII–VIII, three to four rows of larger conical paragnaths with minute conical paragnath on center (Table 26; Figs. 45A–C; 46A, B).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus (Fig. 45E).

In anterior parapodia (Fig. 45F), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule, twice longer than notopodial ventral ligules. Notopodial dorsal ligules oval with tapering tips, subequal to ventral ones; notopodial prechaetal lobes absent; notopodial ventral ligules oval with bluntly tapering tips, notoacicular papillae absent. Neuroacicular ligules shortly globose, postchaetal lobes absent; neuropodial ventral ligules cylindrical, twice longer than neuroacicular ones. Ventral cirri longer than neuropodial ventral ligules, extending beyond their tips.

In middle parapodia (Fig. 45G), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule, three times longer than notopodial ventral ligules. Notopodial dorsal and ventral ligules subequal, globose, notoacicular papillae absent. Neuroacicular ligules subconical, subequal to notopodial ventral ones, postchaetal lobes absent; neuropodial ventral ligules globose. Ventral slightly shorter than neuropodial ventral ligules, not extending beyond their tips.

In posterior parapodia (Fig. 45H), dorsal cirri sub-terminally inserted, extending beyond notopodial dorsal ligule, three times longer than notopodial ventral ligules. Notopodial dorsal ligules subconical, slightly enlarged; notopodial ventral ligules digitate, longer than wide, slightly shorter than notopodial dorsal one, notoacicular papilla absent. Neuroacicular ligules subconical, wider than long, postchaetal lobes absent; neuropodial ventral ligules cylindrical, subequal to neuroacicular ligules. Ventral cirri one and half times longer than neuropodial ventral ligules, extending beyond their tips.

Notochaetae all homogomph spinigers (Fig. 45I) in anterior parapodia, homogomph spinigers and falcigers in middle parapodia, all homogomph flacigers (Fig. 45K) in posterior parapodia. Upper neurochaetae consisting of homogomph spinigers and heterogomph falcigers throughout. Lower neurochaetae consisting of heterogomph spinigers and heterogomph falcigers throughout (Fig. 45J, L). Chaetae decreased in number toward posterior end.

Notopodial homogomph spinigers with long serrated blades (Fig. 45I). Notopodial homogomph falcigers stout with rod-shaped blade (Fig. 45K). Neuropodial homogomph and heterogomph spinigers (Fig. 45J) with long serrated blades. Neuropodial heterogomph falcigers stout with serrated blades, distally incurved (Fig. 45L).

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers are summarized in Table 26.

Habitats

Intertidal and subtidal zones (less than 3 m deep). Associated with sessile organisms such as algae, mussels, and oysters.

Distribution

Type locality: Takami, near Chochi, Japan. Eastern Asia (China, Taiwan, Korea, Japan) (Fig. 47).

Molecular data

The COI sequence data obtained from six individuals (Table 4, Appendix 2).

Remarks

Nereis heterocirrata is distinguishable from other *Nereis* species by having enlarged tentacularphores in ventral tentacular cirri (Fig. 45D) and the presence of minute paragnath on the center of area VII among larger paragnaths (Fig. 45B).

Morphological characteristics of present specimens agreed well with previous description of *N. heterocirrata* (Table 26). Their DNA sequences of COI also differed from those of other *Nereis* species (Fig. 48).

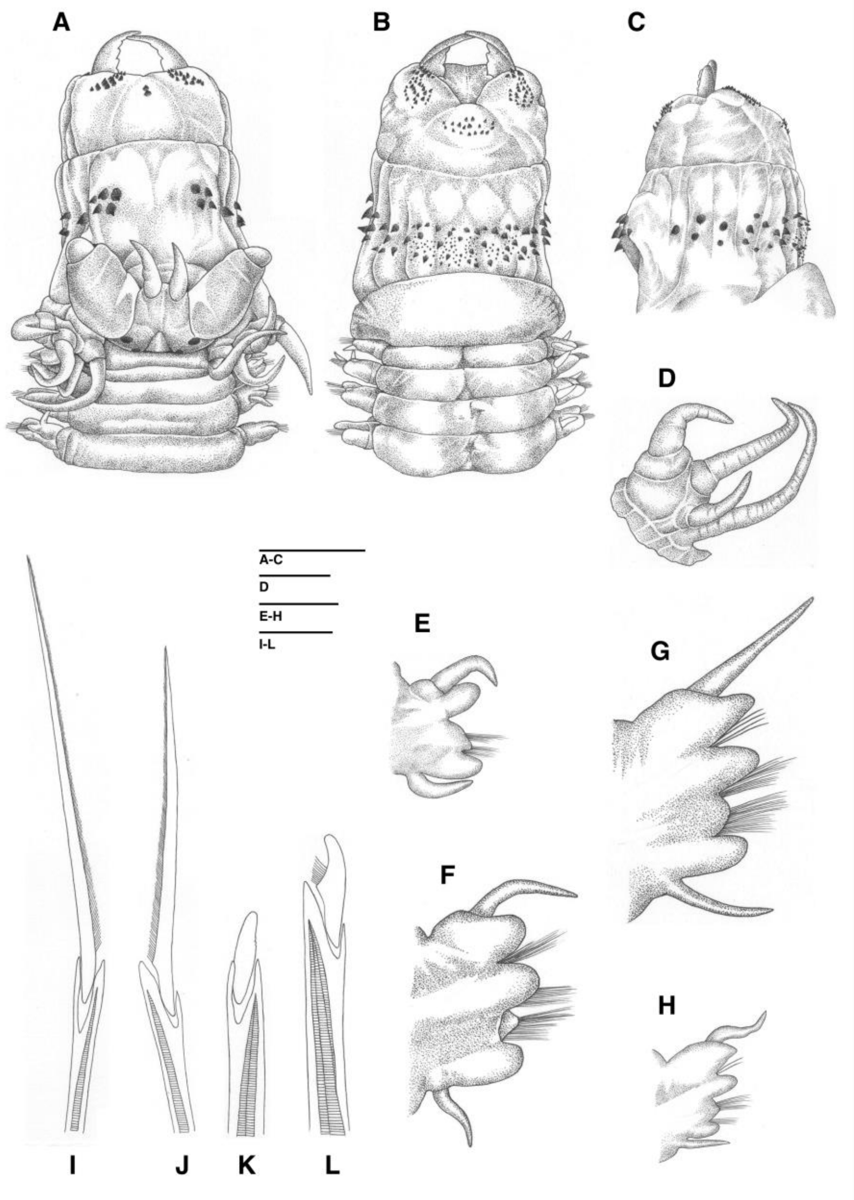

Fig. 45. *Nereis heterocirrata* Treadwell, 1931. (A–C) Dorsal, ventral, and lateral views of anterior end with the everted proboscis. (D) Lateral view of left tentacular cirri. (E–H) Anterior views of parapodium 1 (E); 11 (F); 24 (G); 61 (H). (I) Homogomph spiniger from notochaetae in parapodium 11. (J) Heterogomph spiniger from lower neurochaetae in parapodium 11. (K) Homogomph falciger from notochaetae in parapodium 24. (L) Heterogomph falciger from lower neurochaetae in parapodium 11. Scale bars: 2 mm in (A–C); 1 mm in (D); 0.5 mm in (E–H); 0.04 mm in (I–L).

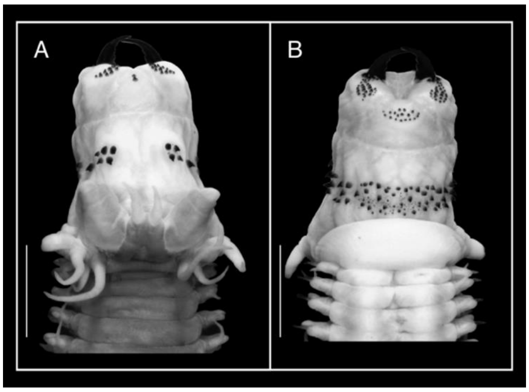

Fig. 46. Dorsal and ventral views of everted proboscis of *Nereis heterocirrata* Treadwell. Scale bars, 2 mm.

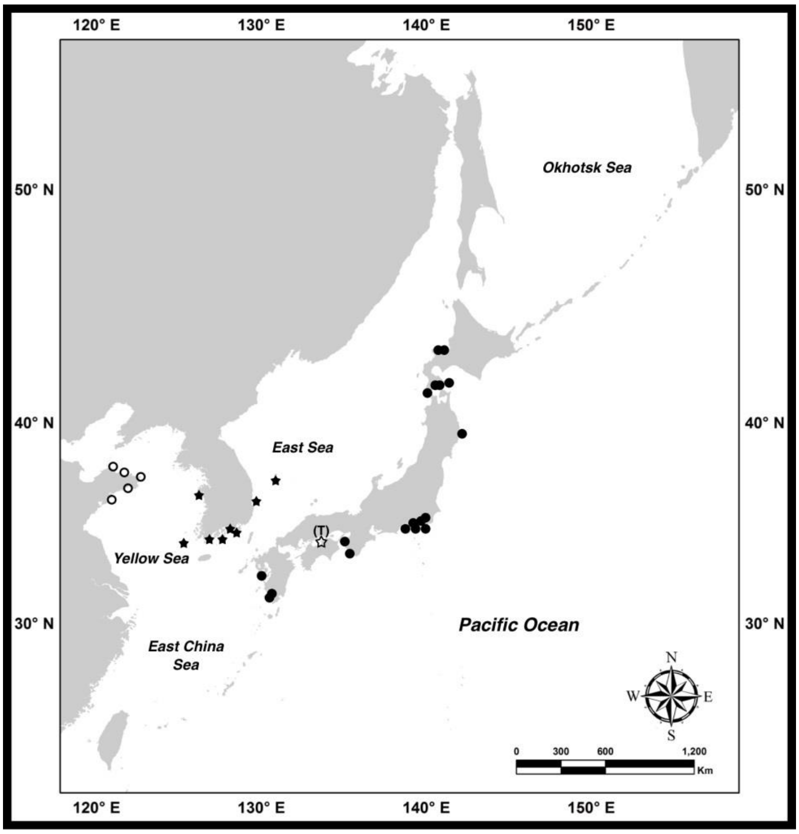

Fig. 47. Distribution of *Nereis heterocirrata* Treadwell, 1931 in Northeast Asia based on the present study (★) and the literature. (☆) Treadwell (1931), (●) Imajima (1972), (○) Wu et al. (1985). (T) Type locality.

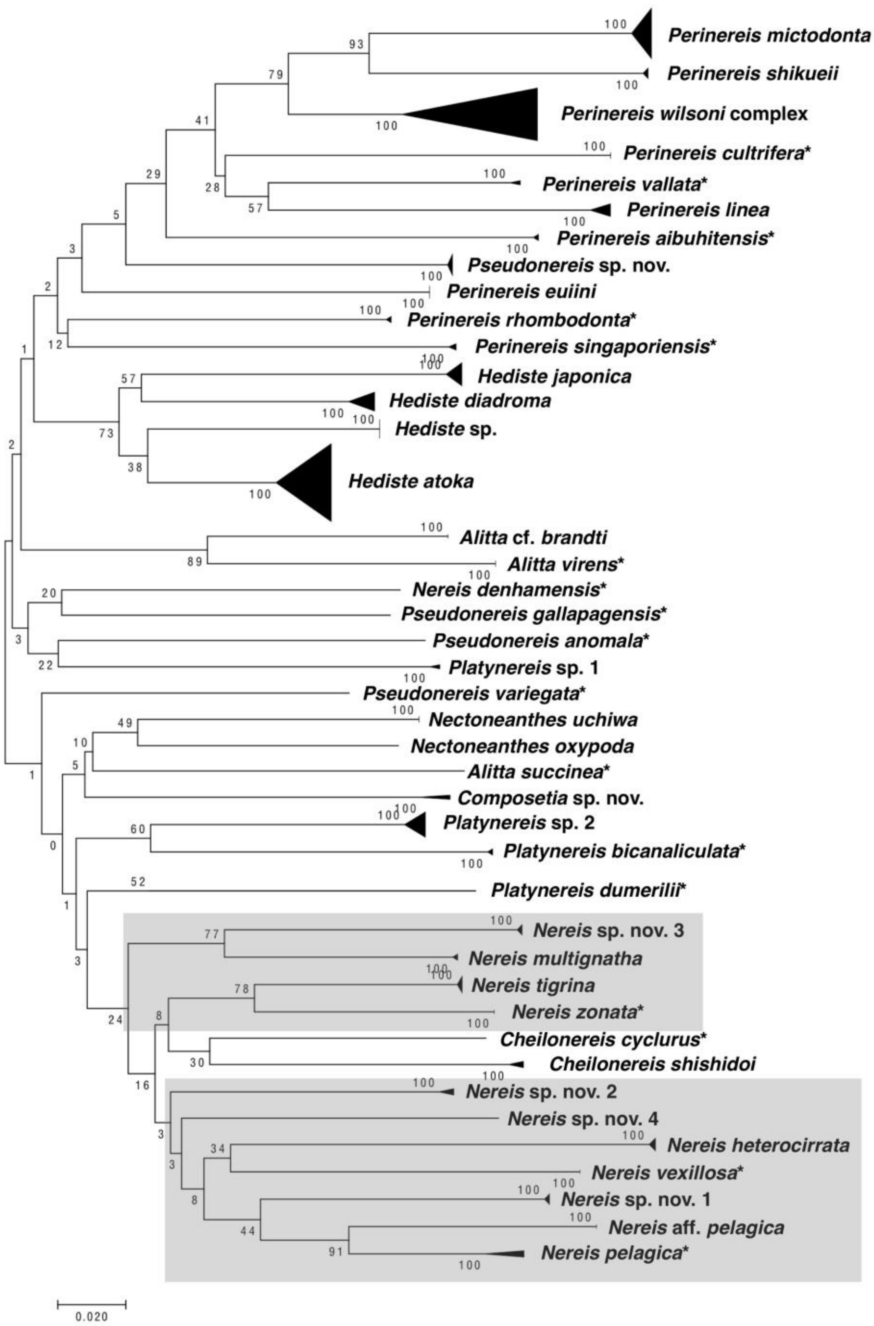

Fig. 48. Neighbor joining analysis (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray box represents the difference of *N. heterocirrata* Treadwell, 1931 among *Nereis* species.

Table 26. Variation in paragnath number in area I to VIII on proboscis of *Nereis heterocirrata* Treadwell, 1931. Ranges (mean ± standard deviation) are shown. L: left side, R: right side.

Locality	**I**	**II(L)**	**II(R)**	**III**	**IV(L)**	**IV(R)**	**V**	**VI(L)**	**VI(R)**	**VII–VIII**
Korea (n=75) (Present study)	1–5 (2.3±0.5)	8–40 (19.2±6.5)	9–38 (19±6.5)	16–51 (29.7±9)	19–49 (34.1±6.6)	18–50 (34.3±6.3)	0–4 (0.1±0.6)	2–6 (4±0.8)	2–6 (4.1±0.8)	27–121 (59.3±15.4) three to four rows of large conical paragnaths with minute paragnat on center
Korea (n=?) (Paik, 1977)	2–3	about 30		about 50	about 50		0	3		two to four irregular rows of large, distally pointed cones, Together with many small paragnaths scattered among the large cones on area VII
Japan (n=?) (Imajima, 1972)	2–3	28–29		about 50	47–48		0	3		

11. *Nereis* aff. *pelagica* (Figs. 49–51)

Nereis pelagica: Marenzeller, 1879: 122; Moore, 1903: 431; Izuka, 1912: 154–156, pl. XVII, figs. 1–6; Annekova, 1937: 162; Uschakov, 1965: 191, fig. 66G–J; Imajima and Hartman, 1964: 147–148; Imajima, 1972: 142–146, figs. 48a–m, 49a–d, 51; Paik, 1977: 193–195, fig. 26A–F; Wu et al., 1985: 120–123, figs. 67A–J, 68A–E.

Materials examined

Non-type materials

NIBRIV0000783695, 2 inds.; NIBRIV0000801064, 1 ind., 8 m in depth, associated with sessile organisms in subtidal rocky area, White Rock dive point in Aquagallery dive resort, Namae-ri, Hyeonnam-myeon, Yangyang-gun, Gangwon-do, Korea (37°56′8″N, 128°47′39″E), 11 June 2013, collected by Taeseo Park and Ye Eun by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783694, 2 inds., associated with sessile organisms in subtidal rocky area, Munamjin-ri, Jukwang-myeon, Goseong-gun, Gangwon-do, Korea, 21 July 2015, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783698, 1 ind., associated with sessile organisms in subtidal rocky area, Geomeunseom dive point, Oho-ri, Jukwang-myeon, Goseong-gun, Korea, 26 July 2011, collected by Taeseo Park by SCUBA diving fixed in 80% ethanol. NIBRIV0000783696, 1 ind., associated with sessile organisms in subtidal rocky area, DBQ dive point in Aquagallery dive resort, Namae-ri, Hyeonnam-myeon, Yangyang-gun, Gangwon-do, Korea, 25 June 2015, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783697, 1 ind.; NIBRIV0000810289, 1 ind.; NIBRIV0000810288, 1 ind., 10 m in depth, associated with sessile organisms in subtidal rocky area, artificial reef dive point in Aquagallery dive resort, Namae-ri, Hyeonnam-myeon, Yangyang-gun, Gangwon-do, Korea, 2 July 2014, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783703, 1 ind., associated with sessile organisms in subtidal rocky area, Fusion dive point in 38marine dive resort, Gisamun-ri, Hyeonbuk-myeon, Yangyang-gun, Gangwon-do, Korea, 14 May 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783704, 1 ind., associated with sessile organisms in subtidal rocky area, fusion dive point in 38marine dive resort, Gisamun-ri, Hyeonbuk-myeon, Yangyang-gun, Gangwon-do, Korea, 13 November 2010, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000810297, 1 ind., associated with sessile organisms in subtidal rocky area, Maisan dive point in Munam dive resort, Munamjin-ri, Jukwang-myeon, Goseong-gun, Gangwon-do, Korea, 1 August 2017, collected by Kwang-Soo Kim by SCUBA diving, fixed in 80% ethanol.

Diagnosis

Pinkish brown colored dorsum in live specimens. Bar-shaped paragnath present or absent in area IV; paragnath absent in area V; paragnaths on area VII–VIII in 2–3 transverse rows of larger paragnaths and minute paragnaths below transverse rows. Noropodial prechaetal lobe and neuropodial postchaetal lobe absent throughout.

Description of atokes

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum pinkish brown color in live individuals.

Prostomium pyriform, slightly longer than wide, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with palpophores and shorter thick-rounded palpostyles. Two pairs of eyes arranged trapezoidally; anterior pair slightly larger than posterior pair; gap of anterior pair slightly wider than posterior pair (Fig. 49A).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 3–4 (Fig. 49A).

Proboscis with pair of dark brown amber jaws, each with 4 teeth of serrated inner margin (Fig. 49B, C). Paragnaths present on both maxillary and oral rings except area V (one specimen with 3). Paragnath numbers and arrangements as follows: area I, 1–4 conical paragnaths; area II with conical paragnath, 10–16 on left, 9–17 on right, arranged in two to three oblique rows; area III, 9–17 conical paragnaths with lateral groups in irregular cluster; area IV with conical paragnath with or without bar-shaped paragnath, 15–27 on left, 11–25 on right, arranged in curved cluster; area VI with conicl paragnath, 3–6 on left, 4–7 on right; areas VII–VIII with 2–3 transverse rows of larger conical paragnaths with minute conical paragnath on oral side (Table 28, Fig. 49B).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus (Fig. 49D).

In anterior parapodia (Fig. 49E), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule, twice longer than notopodial ventral ligules. Notopodial dorsal and ventral ligules digitate, subequal to each other; notopodial prechaetal lobes and notoacicular papillae absent. Neuroacicular ligules subconical, postchaetal lobes absent; neuropodial ventral ligules digitate, subequal to neuroacicular ones. Ventral cirri slightly longer than neuropodial ventral ligules, extending beyond their tips.

In middle parapodia (Fig. 49F), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule, three times longer than notopodial ventral ligules. Notopodial dorsal and ventral ligules subconical, dorsal ligules slightly shorter than ventral ones, notopodial prechaetal lobe and notoacicular papillae absent. Neuroacicular ligules subconical, subequal to neuropodial ventral ligules, postchaetal lobes absent; neuropodial ventral ligules digitate. Ventral cirri subequal to notopodial ventral ligules, not extending beyond their tips.

In posterior parapodia (Fig. 49G), dorsal cirri subterminally inserted, extending beyond notopodial dorsal ligule, more than three times longer than notopodial ventral ligules. Notopodial dorsal and ventral ligules subconical, subequal each other, slightly enlarged, notopodial prechaetal lobe and notoacicular papilla absent. Neuroacicular ligules subconical, wider than long, postchaetal lobes absent; neuropodial ventral ligules digitate, subequal to neuroacicular ligules. Ventral cirri shorter than neuropodial ventral ligules.

Notochaetae all homogomph spinigers (Fig. 49H) in anterior parapodia, homogomph spinigers and falcigers in middle parapodia, all homogomph falcigers (Fig. 49I) in posterior parapodia. Upper neurochaetae consisting of homogomph spinigers and heterogomph falcigers throughout (Fig. 49K, L). Lower neurochaetae consisting of heterogomph spinigers (Fig. 49M) and heterogomph falcigers throughout. Chaetae decreased in number toward posterior end.

Notopodial homogomph spinigers with long serrated blades (Fig. 49H). Notopodial homogomph falcigers stout with rod-shaped blade (Fig. 49I). Neuropodial homogomph and heterogomph spinigers with long serrated blades (Fig. 49K, M). Neuropodial heterogomph falcigers in anterior parapodia slender with medium serrated blades, distally incurved; in posterior parapodia stout with short serrated blades, distally incurved.

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers are summarized in Table 28.

Habitats

Intertidal and subtidal zones. Associated with sessile organisms such as algal roots, mussels, and oysters.

Distribution

Type locality: unknown (maybe in Western Europe). Northeast Asia (China, Korea, Japan) (Fig. 50).

Molecular data

The COI sequences obtained from two individuals (Table 4, Appendix 2).

Remarks

Nereis pelagica is a type species of the family Nereididae. It has been reported to be a cosmopolitan species (Bakken and Wilson, 2005). The very first report of this species in Northeastern Asia from Yokohama, Japan was described by Marenzeller (1879). Thereafter, some researchers have reported this species from Northeast Asian waters (Russian Rar East, China, and Korea) (Annekova, 1937; Wu et. al., 1985; Paik, 1977).

Key morphological characteristics of present specimens well agreed with previous descriptions of *N. pelagica sensu lato* from Northeast Asian waters (Table 28). DNA sequences of COI from present specimens and specimens from Europe and Alaska markedly differed from one another (Fig. 51, Table 27). However, specimens from broad areas (the Pacific and Atlantic Ocean) should be reexamined and compared to confirm the taxonomic status of each population of *N. pelagica sensu lato*.

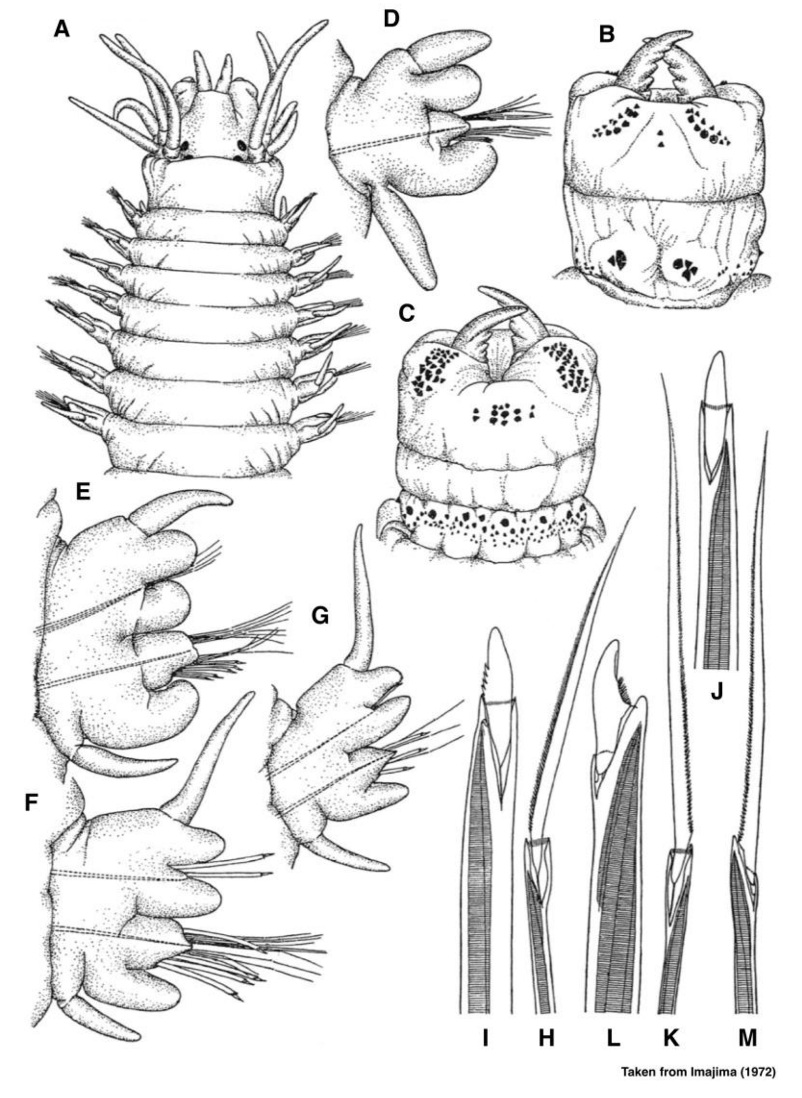

Fig. 49. *Nereis* aff. *pelagica* Linnaeus, 1758, (A–M) taken from Imajima (1972) as *Nereis pelagica*. (A) Dorsal view of anterior end. (B, C) Dorsal and ventral views of anterior end with everted proboscis. (D) Anterior view of parapodium 1. (E) Anterior view of fifth parapodium. (F) Anterior view of median parapodium. (G) Anterior view of posterior parapodium. (H) Notopodial homogom spiniger from anterior parapodium. (I) Notopodial homogomph falciger from median parapodium. (J) Notopodial homogomph falciger from posterior parapodium. (K) Homogomph spiniger in upper neurochaetae from median parapodium. (L) Heterogomph falciger from in upper neurochaetae. (M) Heterogomph spiniger in neuropodial lower chaetae from median parapodium. Magnification: 13× in (A); 15× in (B, C); 36× in (D–G); 320× in (H); 375× in (I, J, L); 320× in (K, M).

Table 27. Mean pairwise genetic distances (K2P distance) based on COI sequences among *Nereis* aff. *pelagica* Linnaeus, 1758 and *N. pelagica* from Europe, and *N. pelagica* from Alaska. n = individuals.

Species	*N.* aff. *pelagica*	*N. pelagica* from Europe	*N. pelagica* from Alaska
N. aff. *pelagica* (n=2)	0.000	0.126	0.122
N. pelagica from Europe (n=2)	0.126	0.005	0.022
N. pelagica from Alaska (n=1)	0.122	0.022	-

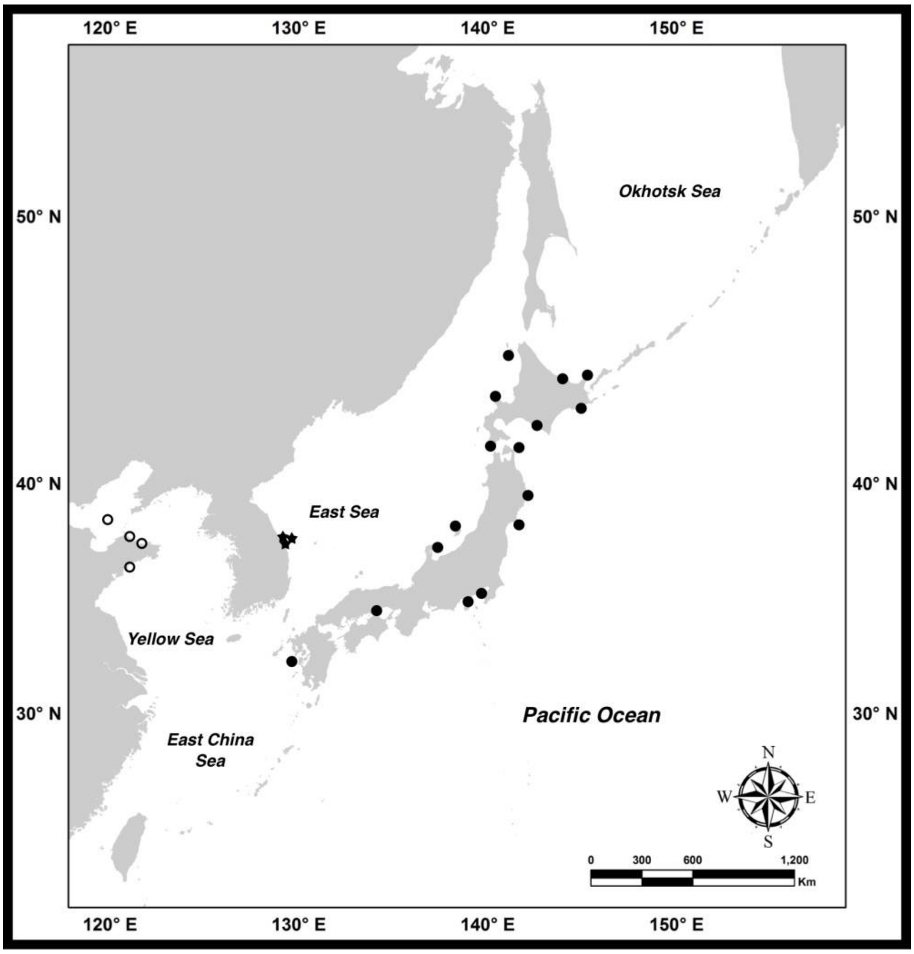

Fig. 50. Distribution of *Nereis* aff. *pelagica* Linnaeus, 1758 in Northeast Asia based on the present study (★) and the literature. (●) Imajima (1972), (○) Wu et al. (1985).

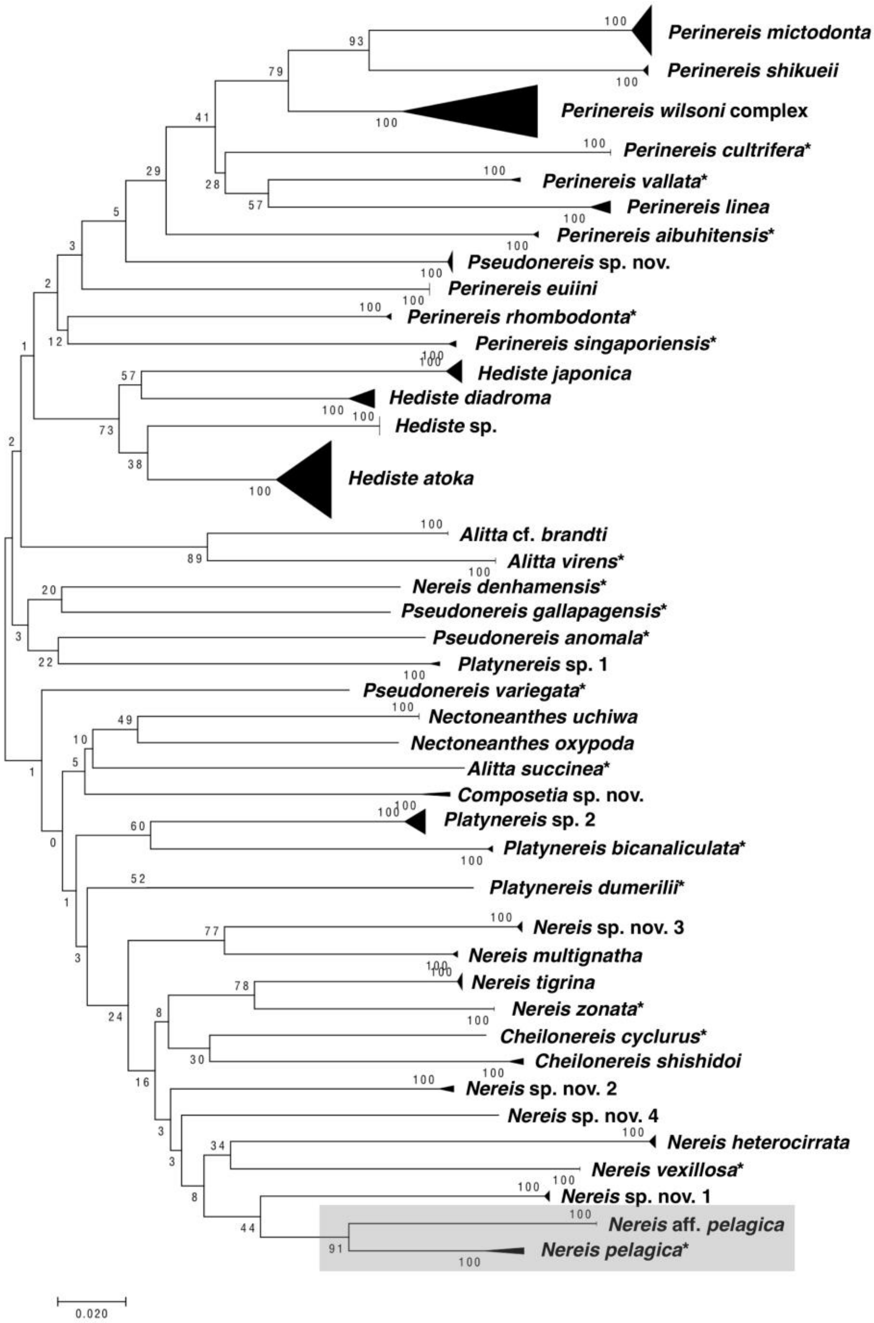

Fig. 51. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray box represents the difference of *N.* aff. *pelagica* Linnaeus, 1758 and *N. pelagica* from Europe and Alaska.

Table 28. Comparison of key characteristics of *Nereis pelagica sensu lato* from Northeast Asian waters. Ranges (mean ± standard deviation) are shown. L: left side, R: right side.

Locality	Range of paragnath number									
	I	**II(L)**	**II(R)**	**III**	**IV(L)**	**IV(R)**	**V**	**VI(L)**	**VI(R)**	**VII–VIII**
Korea (n=11) (Present study)	1–4 (2.4±0.9)	10–16 (12.6±2.1)	9–17 (12.7±2.4)	9–17 (13.3±2.8)	15–27 (21.2±4.3)	11–25 (21±4.6)	0	3–6 (4.4±1)	4–7 (4.4±1)	2–3 transverse rows of larger paragnaths and minute paragnaths below transverse rows
Korea (n=?) (Paik, 1977)	2	15		?	25–30		0	4		a row of larger cones on the maxillary side, and 2–3 rows of tiny cones on the oral side
Japan (n=?) (Imajima, 1972)	2–3	12–14		10–15	24–30		0	4		
China (n=?) (Wu et al., 1985)	1–2	10–14		14–18	16–20		0	2–3	4–6	large cones in a row near maxillary ring, below it small cones in 3–5 rows

12. *Nereis* sp. nov. 1 (Figs. 52, 53A–C, 54, 55)

Nereis denhamensis: Imajima, 1972: 120–122, figs. 30a–m, 51; 1996: 148–149, figs. 118a–j, 118'a–g; Paik, 1977: 182, fig. 20A–F; 1982: 787, pl. 13d–f; 1989: 323–324.

Materials examined

Type material

Holotype, NIBRIV0000783661, associated with sessile organism in subtidal rocky area, Jejudo Is., near Beomseom islet, Beophwan-dong, Seogwipo-si, Jeju-do, Korea, 1 April 2016, collected by Taeseo Park and Kwang-Soo Kim by SCUBA diving, fixed in 80% ethanol. Paratypes, NIBRIV0000783663, 2 inds., associated with sessile organism in subtidal rocky area, Wangdolcho reef, Uljin-gun, Gyeongsangbuk-do, Korea, 14 August 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol.

Non-type materials

NIBRIV0000783664, 1 ind., associated with sessile organisms in subtidal artificial reef, Hawoomokdong artificial point, Udo Is., Udo-myeon, Jeju-si, Jeju-do, Korea, 20 October 2011, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783665, 1 ind., associated with sessile organisms in subtidal rocky area, near Munseom islet, Seogwipo-si Jeju-do, Korea, 31 March 2016, collected by Taeseo Park and Kwang-Soo Kim by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783666, 1 ind., associated with sessile organisms in subtidal rocky area, Neopgae point, Gapado Is., Gapa-ri, Daejeong-eup, Seogwipo-si, Jeju-do, Korea, 19 August 2015, collected by Taeseo Park and Kwang-Soo Kim by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783667, 1 ind., associated with sessile organisms in subtidal rocky area, Gichabawi point near Beomseom islet, Beophwan-dong, Seogwipo-si, Jeju-do, Korea, 29 October 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783668, 1 ind., associated with sessile organisms in subtidal rocky area, Biyangdo Is., Hallim-eup, Jeju-si, Jeju-do, Korea, 24 September 2011, collected by Taeseo Park by SCUBA diving, fixed in 70% ethanol. NIBRIV0000783669, 1 ind., associated with sessile organisms in subtidal rocky area, Jakeunhangaechang dive point near Beomseom islet, Seogwi-dong, Seogipo-si, Jeju-si, Jeju-do, Korea, 5 December 2016, collected by Taeseo Park and Seul Yi by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783670, 4 inds.; NIBRIV0000783683, 1 ind., associated with sessile organisms in subtidal rocky area, Coral garden dive point near Beomseom islet, Beophwan-dong, Seogwipo-si, Jeju-do, Korea, 10 August 2016, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783671, 1 ind., associated with sessile organisms in subtidal rocky area, Hangaechang dive point near Seopseom islet, Bomok-dong, Seogwipo-si, Jeju-do, Korea, 30 October 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783672, 1 ind., associated with sessile organisms in subtidal rocky area, Yieopo, Geomundo Is., Samsan-myeon, Yeosu-si, Jeollanam-do, Korea, 24 April 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783673, 1 ind., associated with sessile organisms in subtidal rocky area, Geobukbawi dive point in Tongumi, Namyang-ri, Seo-myeon, Ulleung-gun, Gyeongsangbuk-do, Korea (37°27′38″N, 130°51′24″E), 25 September 2012, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783674, 1 ind.; NIBRIV0000783687, 2 inds., associated with sessile organisms in subtidal rocky area, Baesimpo point, Geomundo Is., Samsan-myeon, Yeosu-si, Jeollanam-do, Korea (34°3′32″N, 127°19′34″E), 23 April 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783675, 1 ind.; NIBRIV0000783677, 3 inds., associated with sessile organisms in subtidal rocky area, artificial reef near Yulim Beach, Geomundo Is., Samsan-myeon, Yeosu-si, Jeollanam-do, Korea, 25 April 2013, collected by Jin-Ho Park and Sang-Hwi Lee by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783676, 1 ind., associated with sessile organisms in subtidal rocky area, Janggae dive point, Geomundo Is., Samsan-myeon, Yeosu-si, Jeollanam-do, Korea, 18 April 2009, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol.

NIBRIV0000783678, 17 inds.; NIBRIV0000783686, 1 ind., associated with sessile organisms in subtidal rocky area, Holaemiseom dive point near Gapado Is., Gapa-ri, Daejeong-eup, Seogwipo-si, Jeju-do, Korea, 16 November 2016, collected by Taeseo Park and Seul Yi by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783679, 6 inds.; NIBRIV0000783682, 5 inds., associated with sessile organisms in subtidal rocky area, Yulim Beach, Geomundo Is., Samsan-myeon, Yeosu-si, Jeollanam-do, Korea (34°2′24″N, 127°21′34″E), 25 April 2013, collected by Ye Eun by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783680, 4 inds., associated with sessile organisms in subtidal rocky area, Jigwi islet, Wimi-ri, Namwon-eup, Seogwipo-si, Jeju-do, Korea, 19 November, collected by Taeseo Park, Kwang-Soo Kim, and Seul Yi by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783681, 1 ind., associated with sessile organisms in subtidal rocky area, Deungdae point, Gapado Is., Gapa-ri, Daejeong-eup, Seogwipo-si, Jeju-do, Korea, 11 November 2016, collected by Taeseo Park, Seul Yi, and Gwang-Soo Kim by SCUBA diving, fixed in 80% ethanol. NIBRIV0000159984, 1 ind., associated with sessile organisms in subtidal rocky area, near Beomseom islet, Beophwan-dong, Seogwipo-si, Jeju-do, Korea (33°12′58.7″N, 126°31′6.7″E), 1 May 2009, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783685, 1 ind., Hyeongje islet dive point, Sagye-ri, Andeok-myeon, Seogwipo-si, Jeju-do, Korea, 20 November 2016, collected Taeseo Park, Seul Yi, and Kwang-Soo Kim by SCUBA diving, fixed in 80% ethanol.

Diagnosis

Pinkish brown colored dorsum in live specimens. Bar-shaped paragnath present or absent in area IV; paragnath absent in area V; paragnaths on area VII–VIII arranged in single transverse row in small individuals, one to three rows of minute paragnaths added below single transverse row in large individuals. Noropodial prechaetal lobe and neuropodial postchaetal lobe absent throughout.

Description of atokes

Holotype, complete with 78 chaetigers, 52 mm long, 2.1 mm and 2.7 mm wide excluding and including parapodia at chaetiger 10, respectively.

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum pinkish brown color in live individuals.

Prostomium pyriform, slightly longer than wide, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with palpophores and shorter thick-rounded palpostyles. Two pairs of eyes arranged trapezoidally; anterior pair slightly larger than posterior pair; gap of anterior pair slightly wider than posterior pair (Fig. 52A).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 3 (3–4 in other materials examined) (Figs. 52A, B; 53A, B).

Proboscis with pair of dark brown amber jaws, each with 4 teeth of serrated inner margin. Paragnaths present on both maxillary and oral rings except area V. Paragnath numbers and arrangements in holotype as follows (range in other material given in parentheses): area I, 1 (1–2) conical paragnaths; area II with conical paragnath, 13 (6–15) on left, 11 (6–17) on right, arranged in two to three oblique rows; area III, 7 (2–14) conical paragnaths without lateral groups in irregular cluster; area IV with conical and bar-shaped paragnath, 20 (9–24) on left include 2 (0–5) bar shaped paragnaths toward jaw, 17 (10–23) on right include 2 (0–3) bar-shaped paragnaths toward jaw, arranged in curved cluster; area V, none; area VI with conicl paragnath, 3 (2–6) on left, 2 (1–5) on right; areas VII–VIII with 35 (8–62) paragnaths arranged single transverse row of larger conical paragnaths with minute conical paragnath on oral side (Figs. 52A, B; 53A–F). Only single transverse row of conical paragnaths present on area VII–VIII in small individuals (Fig. 53F).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus.

In anterior parapodia (Fig. 52C), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule, twice longer than notopodial ventral ligules. Notopodial dorsal and ventral ligules digitate, subequal to each other; notopodial prechaetal lobes and notoacicular papillae absent. Neuroacicular ligules subconical, postchaetal lobes absent; neuropodial ventral ligules digitate, subequal to neuroacicular ones. Ventral cirri slightly longer than neuropodial ventral ligules, extending beyond their tips.

In middle parapodia (Fig. 52D), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule, three times longer than notopodial ventral ligules. Notopodial dorsal and ventral ligules subconical, dorsal ligules slightly shorter than ventral ones, notopodial prechaetal lobe and notoacicular papillae absent. Neuroacicular ligules subconical, subequal to neuropodial ventral ligules, postchaetal lobes absent; neuropodial ventral ligules digitate. Ventral cirri subequal to notopodial ventral ligules, not extending beyond their tips.

In posterior parapodia (Fig. 52E), dorsal cirri subterminally inserted, extending beyond notopodial dorsal ligule, more than three times longer than notopodial ventral ligules. Notopodial dorsal and ventral ligules subconical, subequal each other, slightly enlarged, notopodial prechaetal lobe and notoacicular papilla absent. Neuroacicular ligules subconical, wider than long, postchaetal lobes absent; neuropodial ventral ligules digitate, subequal to neuroacicular ligules. Ventral cirri shorter than neuropodial ventral ligules.

Notochaetae all homogomph or sesquigomph spinigers (Fig. 52K) in anterior parapodia, homogomph or sesquigomph spinigers and homogomph falcigers in middle parapodia, all homogomph falcigers in posterior parapodia. Upper neurochaetae consisting of homogomph spinigers and heterogomph falcigers throughout (Fig. 52H). Lower neurochaetae consisting of heterogomph spinigers and heterogomph falcigers throughout (Fig. 52I, J). Chaetae decreased in number toward posterior end.

Notopodial homogomph or sesquigomph spinigers with long serrated blades (Fig. 52K). Notopodial homogomph falcigers stout with rod-shaped blade (Fig. 52F, G). Neuropodial homogomph and heterogomph spinigers (Fig. 52J) with long serrated blades. Neuropodial heterogomph falcigers in anterior parapodia (Fig. 52I) slender with medium serrated blades, distally incurved; in posterior parapodia stout with short serrated blades, distally incurved (Fig. 52H).

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers are summarized in Table 30.

Habitats

Subtidal zones associated with various sessile organisms.

Distribution

Type locality: Beomseom islet in Jejudo Island, Korea. East Asia (China, Korea, Japan) (Fig. 54).

Molecular data

The COI sequences obtained from five individuals (Table 4, Appendix 2).

Remarks

Nereis sp. nov. 1 is similar to *N. denhamensis* Augener, 1913 (type locality: Western Australia) in terms of the presence of single row of paragnaths with scattered minute paragnaths in area VII–VIII (Fig. 52B; 53B, C), but different from *N. denhamensis* Augener, 1913 in terms of having many scattered minute paragnaths in area VII–VIII in large individuals and only a single row of paragnaths in small individuals (Table 31).

Morphological characteristics of all specimens previously referred as *N. denhamensis* from Northeast Asian waters (i.e., Japan and Korea, Imajima, 1972; Paik, 1977) agreed well with those of *N*. sp. nov. 1 (Fig. 53, Table 31). Consequently, they all belong to *N*. sp. nov. 1 in that *N. denhamensis* is not distributed in Northeast Asian waters.

Nereis sp. nov. 1 is also similar to *N*. aff. *pelagica* from this study. However, it clearly differs from *N*. aff. *pelagica* in the following diagnostic characteristics: (1) the absence of lateral groups of paragnaths on area III, in contrast to the presence of those in *N*. aff. *pelagica*, and (2) paragnaths in area VII–VIII consist of a single row of larger paragnaths with minute paragnaths, in contrast to those consisting of 2–3 rows of larger paragnaths with minute paragnaths in *N*. aff. *pelagica* (Fig. 53, Table 31).

Comparisons of DNA sequences of COI among *Nereis* sp. nov 1, *N. denhamensis* from Australia, and *N*. aff. *pelagica* support this conclusion. DNA sequences of *N*. sp. nov. 1 markedly differed from *N. denhamensis* from Australia and *N*. aff. *pelagica* (Fig. 55, Table 29).

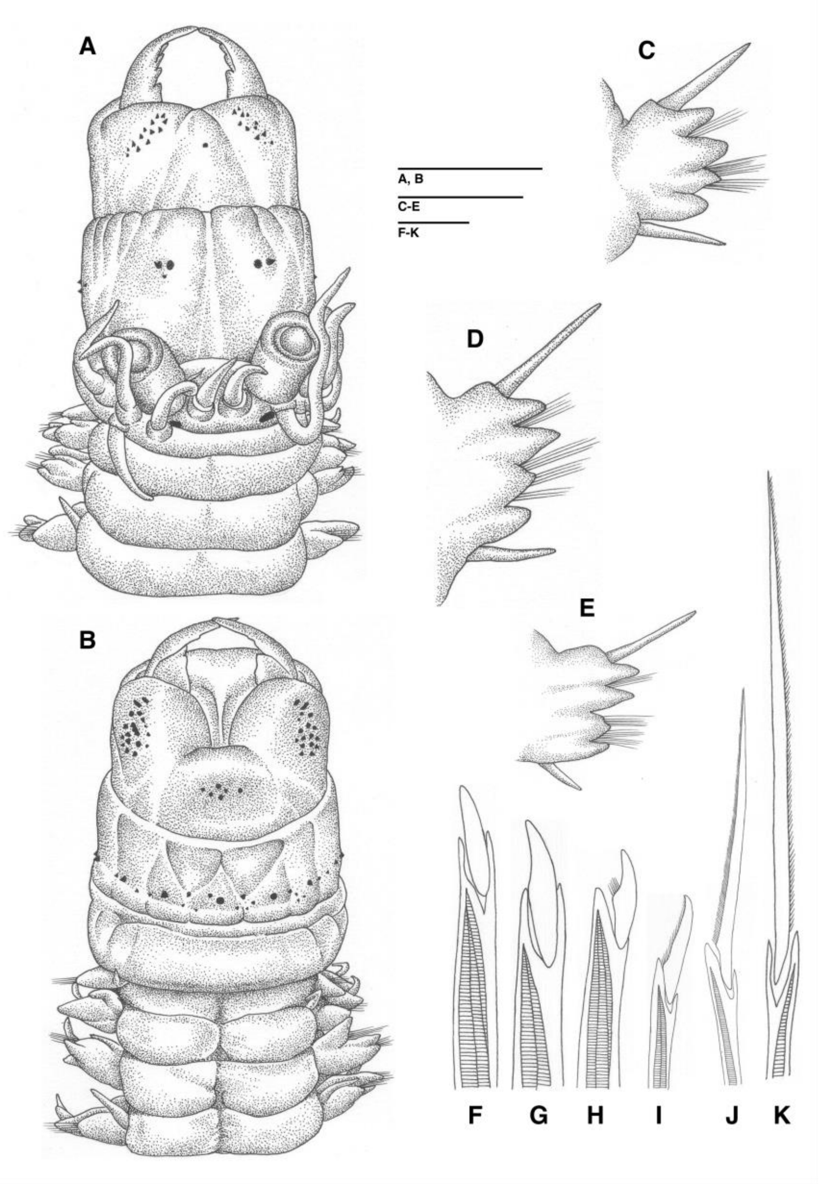

Fig. 52. *Nereis* sp. nov. 1, holotype, NIBRIV0000783661. (A, B) Dorsal and ventral views of anterior end with the everted proboscis. (C–E) Anterior views of parapodium 6 (C); 24 (D); 47 (E). (F) Homogomph falciger from notochaetae in parapodium 47. (G) Homogomph falciger from notochaetae in parapodium 27. (H) Heterogomph falciger from upper neurochaetae in parapodium 47. (I) Heterogomph falciger from lower neurochaetae in parapodium 6. (J) Heterogomph spiniger from lower neurochaetae in parapodium 47. (K) Sesquigomph spiniger from notochaetae in parapodium 6. Scale bars: 1 mm in (A, B); 2 mm in (C–E); 0.02 mm in (F–K).

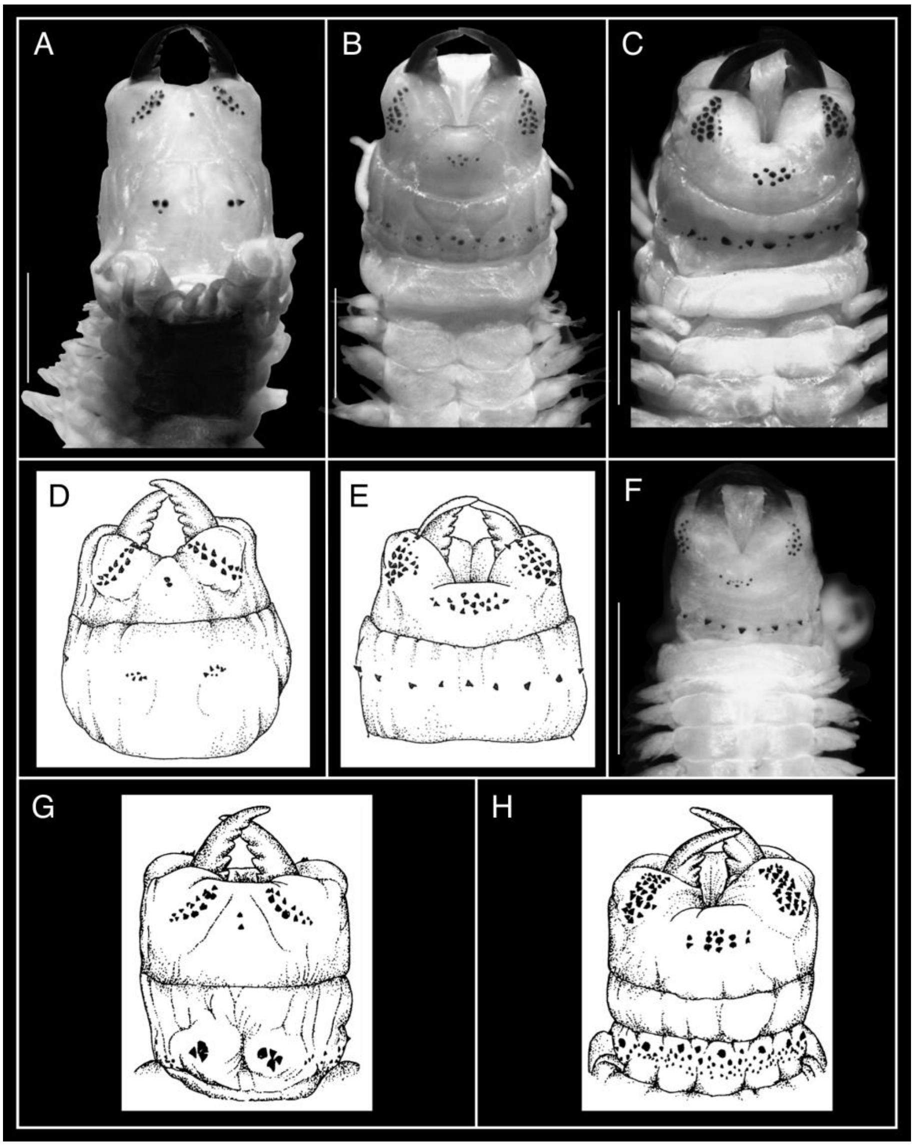

Fig. 53. Dorsal and ventral views of everted proboscis of *Nereis* sp. nov. 1 and *N*. aff. *pelagica* Linnaeus, 1758. (A–F) *N*. sp. nov. 1: (A, B) holotype; (C) non-type (NIBRIV0000738669); (D, E) *N. denhamensis sensu* Imajima (1972) (modified from Imajima, 1972); (F) non-type (NIBRIV0000738670). (G, H) *N. pelagica sensu* Imajima, 1972 (modified from Imajima, 1972). Scale bars, 2 mm.

Table 29. Mean pairwise genetic distances (K2P distance) based on COI sequences among *Nereis* sp. nov. 1 and *N. dnehamensis* Augener, 1913, and *N.* aff. *pelagica* Linnaeus, 1758. n = individuals.

Species	*N.* sp. nov. 1	*N. denhamensis*	*N.* aff. *pelagica*
N. sp. nov. 1 (n=5)	0.001	0.268	0.175
N. denhamensis (n=1)	0.268	-	0.255
N. aff. *pelagica* (n=2)	0.175	0.255	0.000

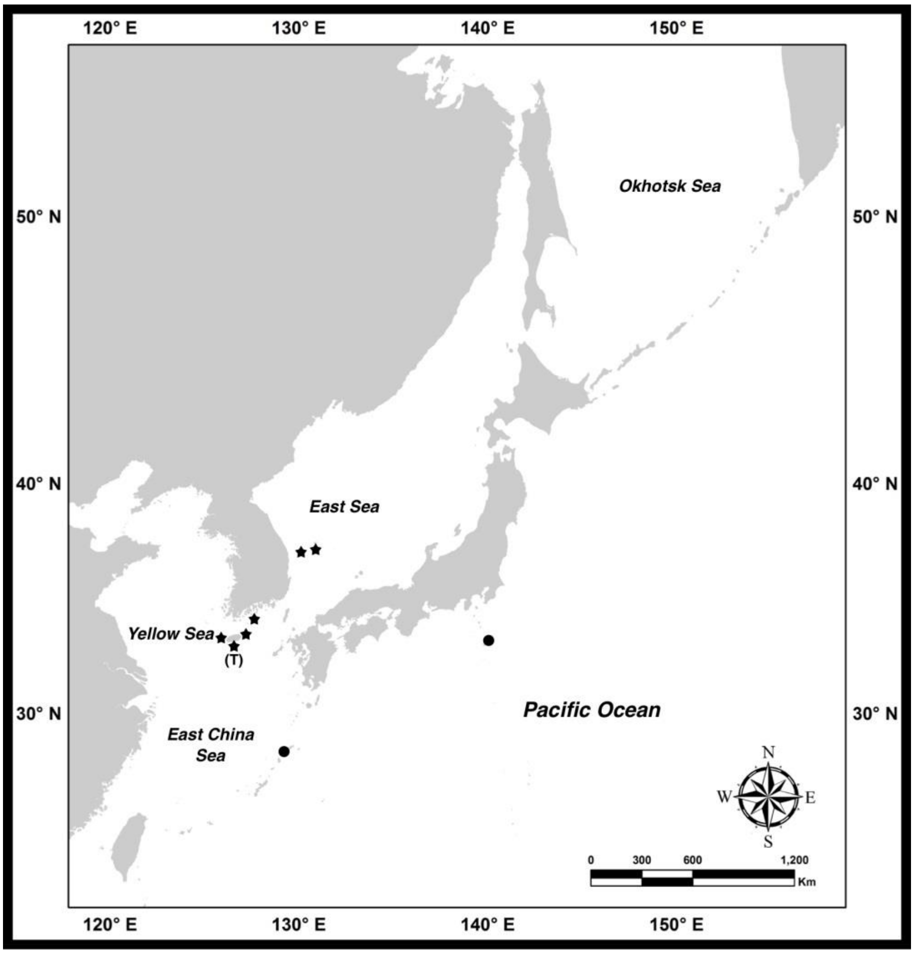

Fig. 54. Distribution of *Nereis* sp. nov. 1 in Northeast Asia based on the present study (★) and the literature. (●) Imajima (1972). (T) Type locality.

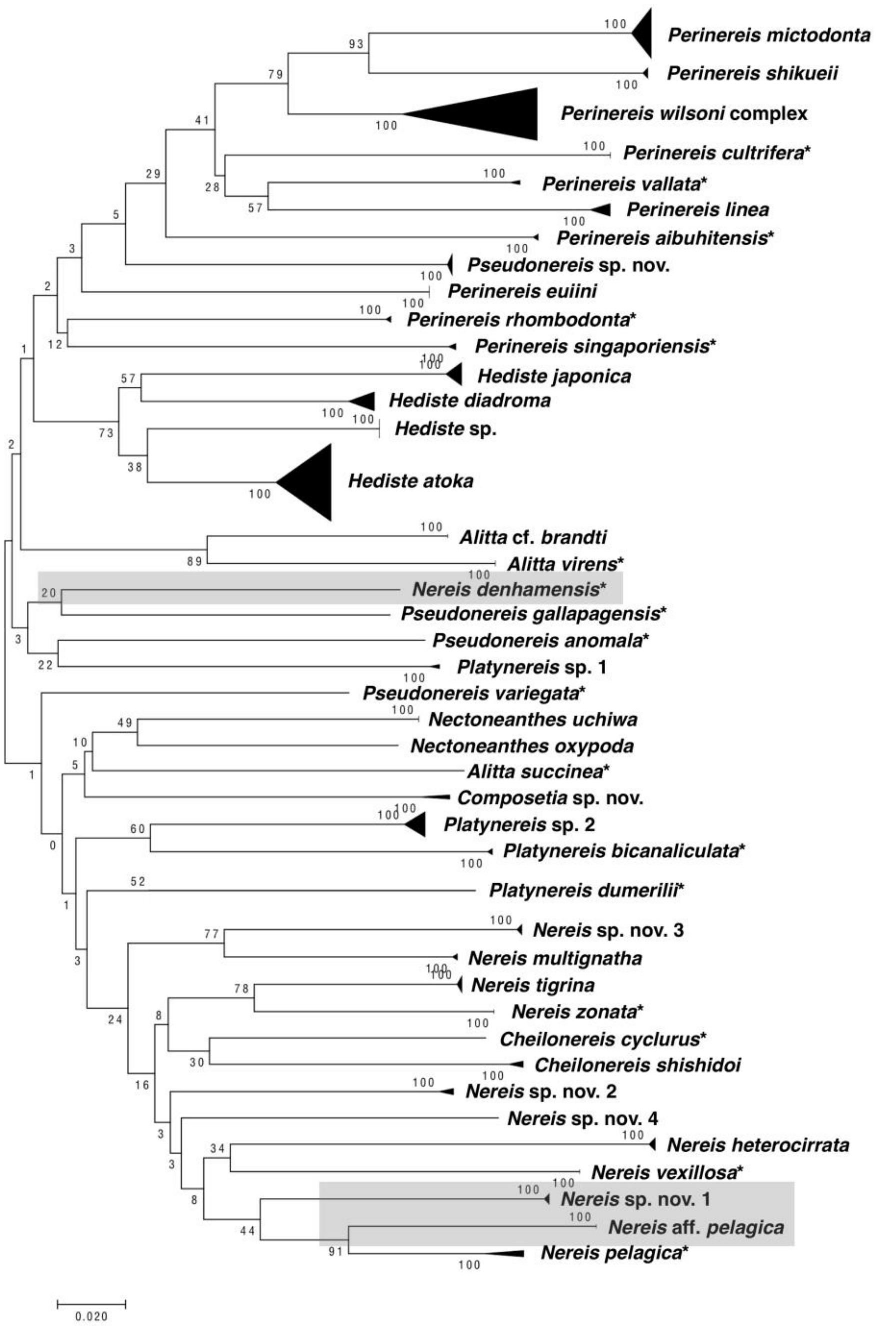

Fig. 55. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray boxes represent the difference among *Nereis.* sp. nov. 1, *N.* aff. *pelagica* Linnaeus, 1758, and *N. denhamensis* Augener, 1913.

Table 30. Variation in paragnath number in area I to VI on proboscis of *Nereis* sp. nov. 1. Ranges (mean ± standard deviation) are shown. L: left side, R: right side.

<table>
<tr><th>Locality</th><th>I</th><th>II(L)</th><th>II(R)</th><th>III</th><th>IV(L)</th><th>IV(R)</th><th>V</th><th>VI(L)</th><th>VI(R)</th></tr>
<tr><td>Korea (n=61)
(Present study)</td><td>1–2
(1.3±0.5)</td><td>6–15
(11.2±2)</td><td>6–17
(11.6±2.2)</td><td>2–14
(8.1±2.2)</td><td>9–24
(16.3±3.3)</td><td>10–23
(16±2.8)</td><td>0</td><td>2–6
(3.4±0.8)</td><td>1–5
(3.3±0.7)</td></tr>
<tr><td>Korea (n=?)
(Paik 1977 as N. denhamensis)</td><td>2</td><td colspan="2">15</td><td>15</td><td colspan="2">25</td><td>0</td><td colspan="2">6–7</td></tr>
<tr><td>Japan (n=?)
(Imajima 1972 as N. denhamensis)</td><td>0–2</td><td colspan="2">14–15</td><td>16</td><td colspan="2">24–26</td><td>0</td><td colspan="2">6–7</td></tr>
</table>

Table 31. Comparison of key characteristics of *Nereis* sp. nov. 1 with two closely similar species.

Species (Locality and reference)	**Range of paragnath number**								**Arrangement of area VII–VIII**
	I	**II***	**III (total)**	**III* (lateral)**	**IV***	**V**	**VI***	**VII–VIII**	
N. sp. nov. 1 (n=61) (Korea, present study, type and non-types)	1–2	6–17	2–14	absent	9–24	none	1–6	8–62	single transverse row in small individuals, one to three rows of minute paragnaths added below single transverse row in large individuals
(Japan, Imajima 1972 as *N. denhamensis*)	0–2	14–15	16	absent	24–26	none	6–7	12	single transverse row
N. aff. *pelagica* (n=11) (Korea, present study)	1–4	9–17	9–17	present	11–27	none	3–7	?	2–3 transverse rows of larger paragnaths and minute paragnaths below transverse rows
(Japan, Imajima 1972 as *N. pelagica*)	2–3	2–14	10–15	present	24–30	none	4	?	
N. denhamensis (Australia, Hutchings & Turvey 1982, type and non-types)	1–3	7–20	7–24	absent	10–40	none	5–15	6–10	large cones forming a single, evenly spaced row with an additional 0–7 smaller cones scattered about large cones ventrally

*Paragnath numbers on each side.

13. *Nereis* sp. nov. 2 (Figs. 56–58)

Materials examined

Type material

Holotype, NIBRIV0000781332, 15 m in depth, associated with sessile organism in subtidal rocky area, Wangdolcho reef, Uljin-gun, Gyeongsangbuk-do, Korea, 14 August 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol.

Non-type materials

NIBRIV0000801027, 1 ind., 15 m in depth, associated with sessile organism in subtidal rocky area, Wangdolcho reef, Uljin-gun, Gyeongsangbuk-do, Korea, 14 August 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000801028, 1 ind., 10 m in depth, associated with Porifera sp., Semicircular artificial reef point in Aqua gallery dive resort, Namae-ri, Hyeonnam-myeon, Yangyang-gun, Gangwon-do, Korea, 2 July 2014, collected by Taeseo Park and Jong Moon Choi by SCUBA diving, fixed in 80% ethanol. NIBRIV0000787921, 1 ind., 17 m in depth, under stone, PT diving point, Gyeongpodae, Jeo-dong, Gangneung-si, Gangwon-do, Korea, 2 August 2017, collected by Gwang-Soo Kim by SCUBA diving, fixed in 80% ethanol.

Diagnosis

Dark brown colored dorsum in live specimens. Paragnath absent in area I and V; area VII–VIII consisted of several triangular patches, large paragnaths present on maxillary side and small paragnaths present on oral side. Noropodial prechaetal lobe and neuropodial postchaetal lobe absent throughout.

Description of atokes

Holotype, complete with 89 chaetigers, 62 mm long, 2.1 mm and 2.8 mm wide excluding and including parapodia at chaetiger 10, respectively.

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum dark brown color in live and preserved individuals.

Prostomium pyriform with dark brown pigmentation, slightly wider than long, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with palpophores and ovoid palpostyles. Two pairs of eyes arranged trapezoidally; anterior pair slightly smaller than posterior pair; gap of anterior pair slightly wider than posterior pair (Fig. 57A, B).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 3 (3–4) (Figs. 56A, B; 57A, B).

Proboscis with pair of brown amber jaws, each with 5 teeth of serrated inner margin. Conical paragnaths present on both maxillary and oral rings except area I and V. Paragnath numbers and arrangements in holotype as follows (range in other material given in parentheses): area I, none; area II, 70 (57–91) on left, 84 (59–70) on right, arranged in oblique patch; area III, 6 (6–8) without lateral groups; area IV, 23 (23–47) on left, 27 (25) on right, arranged in curved cluster; area V, none; area VI, 9 (8–12) on left, 9 (7–9) on right, arranged transverse rows; areas VII–VIII, 56 (66–81) with single transverse row of larger paragnaths with smaller paragnath on oral side, arranged several triangular patches (Figs. 56A, B; 57A, B).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus (Fig. 57D).

In anterior parapodia (Fig. 57E), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule. Notopodial dorsal and ventral ligules subconical, subequal to each other; notopodial prechaetal lobes and notoacicular papillae absent. Neuroacicular ligules subconical, half length of notopodial dorsal ligules, postchaetal lobes absent; neuropodial ventral ligules subconical, subequal to neuroacicular ones. Ventral cirri shorter than neuropodial ventral ligules.

In middle parapodia (Fig. 57F), dorsal cirri subterminally inserted, extending beyond notopodial dorsal ligule, more than twice longer than notopodial ventral ligules. Notopodial dorsal and ventral ligules subconical, subequal to each other, dorsal ligules slightly slender than ventral ones, notopodial prechaetal lobe and notoacicular papillae absent. Neuroacicular ligules subconical, wider than long, shorter than neuropodial ventral ligules, postchaetal lobes absent; neuropodial ventral ligules digitate. Ventral cirri as long as neuropodial ventral ligules, not extending beyond their tips.

In posterior parapodia (Fig. 57G), dorsal cirri subterminally inserted, extending beyond notopodial dorsal ligule, twice longer than notopodial ventral ligules. Notopodial dorsal ligule enlarged subconical terminally, slightly longer than ventral ligules; notopodial ventral ligules subconical, notopodial prechaetal lobe and notoacicular papilla absent. Neuroacicular ligules subconical, wider than long, postchaetal lobes absent; neuropodial ventral ligules digitate, subequal to notopodial ventral ligules. Ventral cirri as long as than neuropodial ventral ligules, not extending beyond their tips.

Notochaetae all homogomph spinigers in anterior parapodia, homogomph spinigers and falcigers in middle parapodia, all homogomph flacigers in posterior parapodia. Upper neurochaetae consisting of homogomph spinigers and heterogomph falcigers throughout (Fig. 57I, K). Lower neurochaetae consisting of heterogomph spinigers and heterogomph falcigers throughout (Fig. 57J, L). Chaetae decreased in number toward posterior end.

Notopodial homogomph spinigers with long serrated blades. Notopodial homogomph falcigers stout with rod-shaped blade (Fig. 57H). Neuropodial homogomph and heterogomph spinigers with long serrated blades (Fig. 57K, L). Neuropodial heterogomph falcigers in anterior parapodia with serrated medium blades, distally incurved; in posterior parapodia stout with serrated short blades, distally incurved (Fig. 57I, J).

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers are summarized in Table 32.

Habitats

Subtidal rocky area associated with sessile organisms.

Distribution

Type locality: Only known from the type locality (Fig. 58).

Molecular data

The COI sequences obtained from three individuals (Table 4, Appendix 2).

Remarks

Nereis sp. nov. 2 is easily distinguished from other *Nereis* species from Northeast Asian waters by having unique arrangement of paragnaths in area VII–VIII and dark pigmentation on dorsum and peristomium. *Nereis* sp. nov. 2 is similar to *N*. sp. nov. 1 and *N*. aff. *pelagica* from this study in terms of the presence of a single row of large paragnaths with scattered minute paragnaths in area VII–VIII, but different from them in terms of having triangular patches of scattered minute paragnaths below each single paragnath in area VII–VIII (Figs. 56B, 57B).

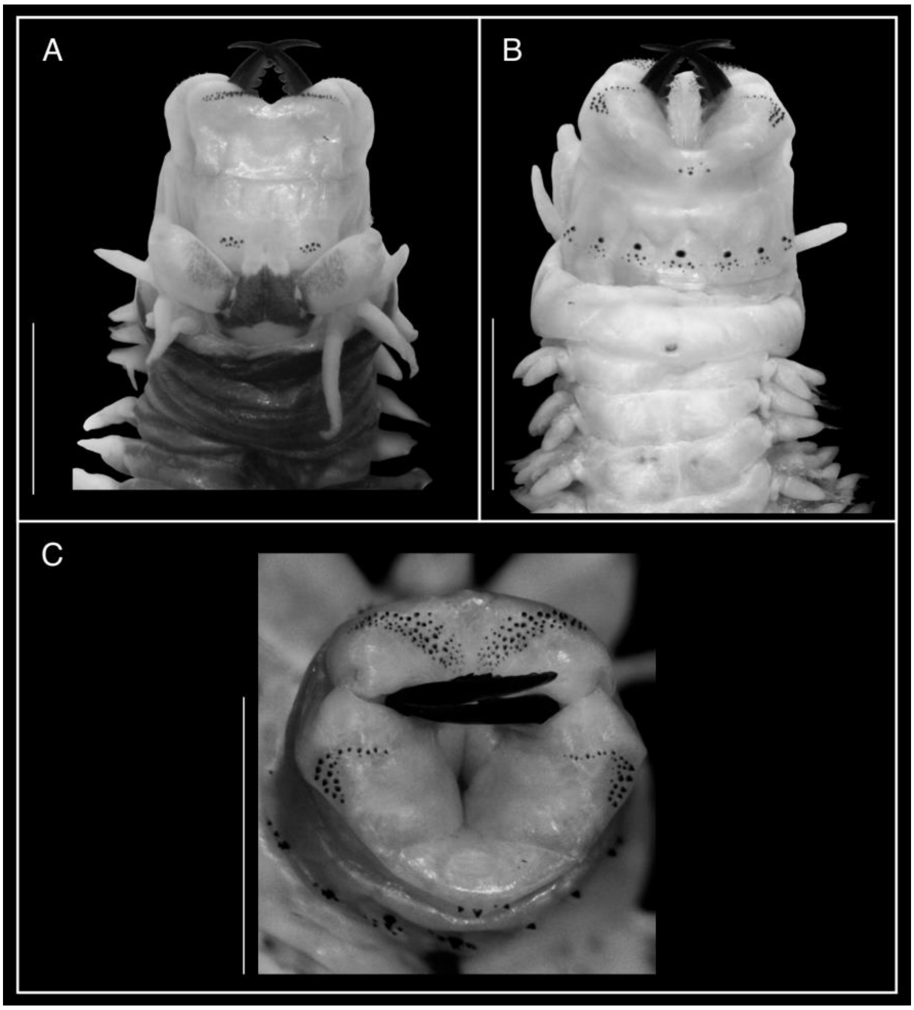

Fig. 56. Dorsal, ventral and frontal views of everted proboscis of *Nereis* sp. nov. 2, holotype, NIBRIV0000781332. (A) Dorsal view, (B) Ventral view, and (C) frontal view. Scale bars, 2 mm.

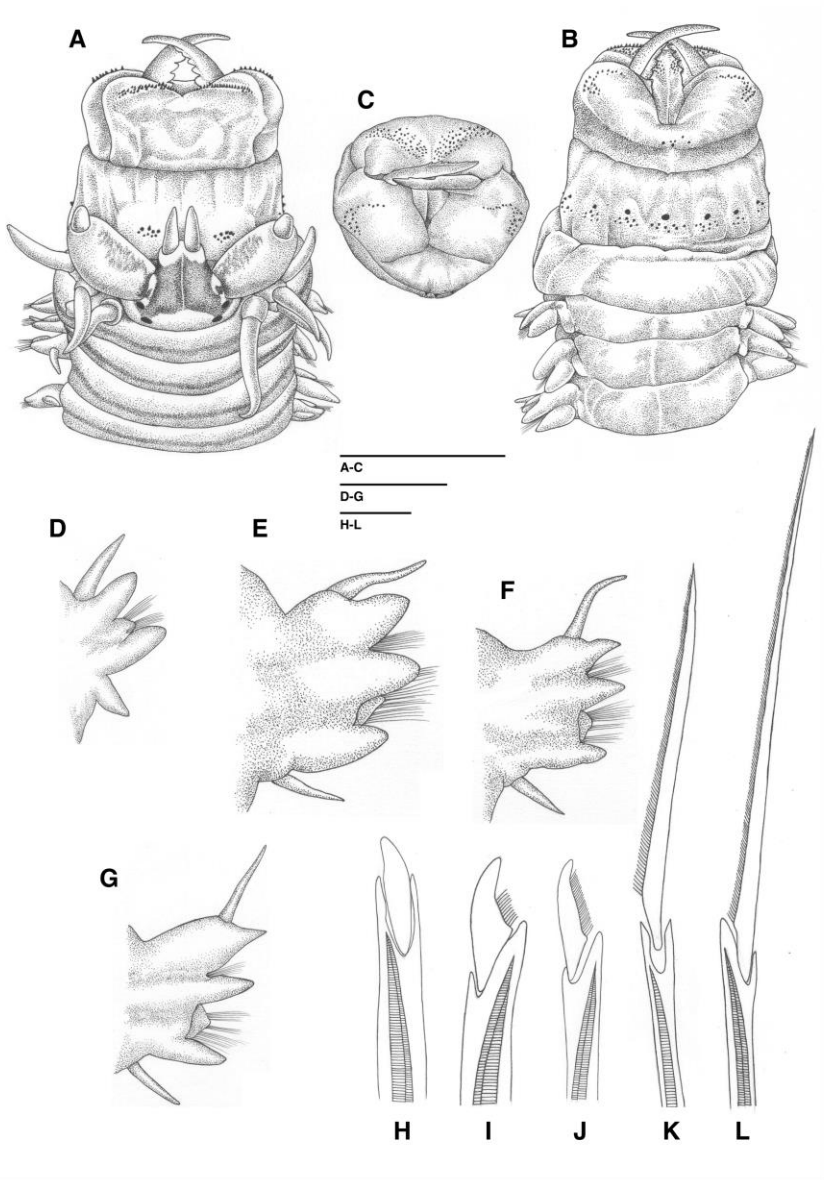

Fig. 57. *Nereis* sp. nov. 2, holotype, NIBRIV0000781332. (A–C) Dorsal, ventral, and frontal views of anterior end with the everted proboscis. (D–G) Anterior views of parapodium 1 (D); 12 (E); 34 (F); 56 (G). (H) Homogomph falciger from notochaetae in parapodium 34. (I) Heterogomph falciger from upper neurochaetae in parapodium 34. (J) Heterogomph falciger from lower neurochaetae in parapodium 12. (K) Homogomph spiniger from upper neurochaetae in parapodium 12. (L) Heterogomph spiniger from lower neurochaetae in parapodium 12. Scale bars: 1 mm in (A–C); 0.5 mm in (D–G); 0.02 mm in (H–L).

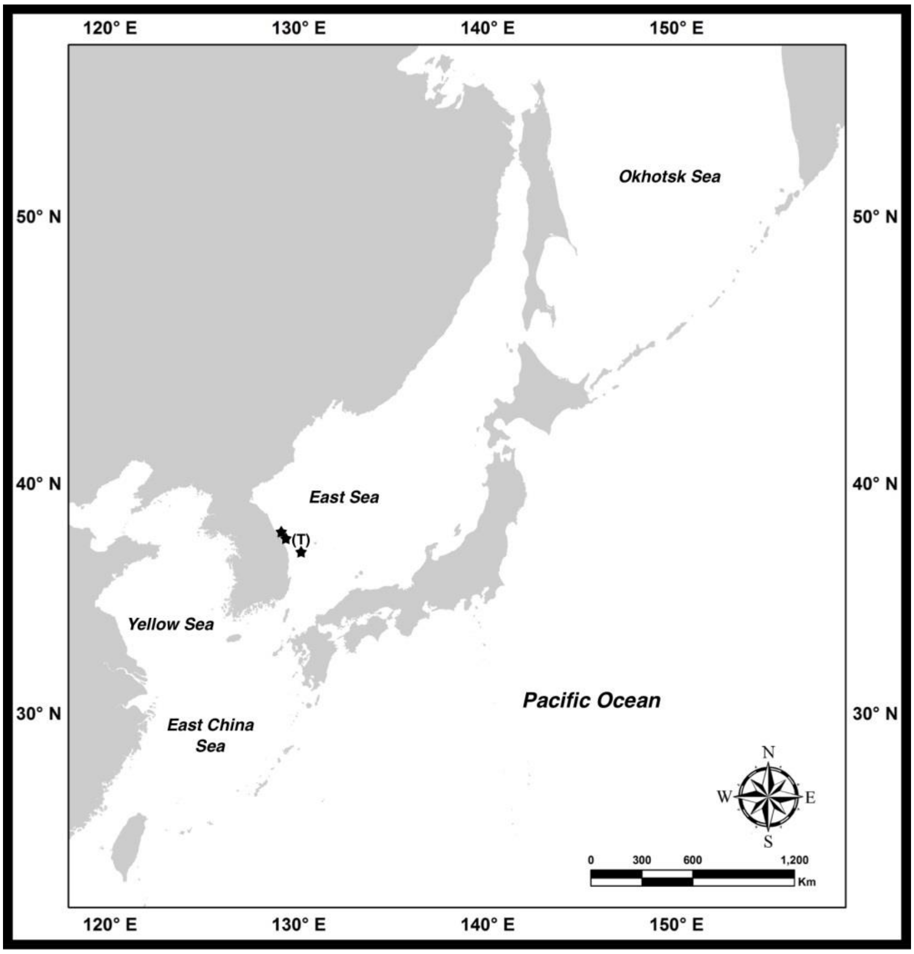

Fig. 58. Distribution of *Nereis* sp. nov. 2 in Northeast Asia based on the present study (★). (T) Type locality.

Table 32. Variation in paragnath number in area I to VIII on proboscis of *Nereis* sp. nov. 2. Ranges (mean ± standard deviation) are shown. L: left side, R: right side.

Locality	I	II(L)	II(R)	III	IV(L)	IV(R)	V	VI(L)	VI(R)	VII–VIII
Korea (n=4) (Present study)	0	57–91 (72.8±14)	59–84 (69.2±10.8)	6–8 (6.5±1)	23–47 (30.3±11.4)	25–27 (25.5±1)	0	8–12 (9.5±1.7)	7–9 (8.3±1)	56–81 (70.25±11.5)

14. *Nereis* sp. nov. 3 (Figs. 59–61, 63A)

Materials examined

Type material

Holotype, NIBRIV0000783838, 5 m in depth, associated with sessile organism in subtidal area, sea squirt farm, Yeongun-ri, Sanyang-eup, Tongyeong-si, Gyeongsangnam-do, Korea (34°81′81″N, 128°43′94″E), 24 March 2016, collected by Taeseo Park and Kwang-Soo Kim, fixed in 80% ethanol, 3 chaetigers on the middle body were used for DNA sequencing.

Non-type materials

NIBRIV0000783837, 1 ind., 5 m in depth, associated with sessile organism in subtidal area, sea squirt farm, Yeongun-ri, Sanyang-eup, Tongyeong-si, Gyeongsangnam-do, Korea (34°81′81″N, 128°43′94″E), 24 March 2016, collected by Taeseo Park and Kwang-Soo Kim, fixed in 80% ethanol. NIBRIV0000801026, 1 ind., intertidal rocky area, associated with sessile organisms, Yulim Beach, Samsan-myeon, Yeosu-si, Jeollanam-do, Korea (34°2′24″N, 127°21′34″E), 25 April 2013, collected by Ye Eun, fixed in 80% ethanol. NIBRIV0000783836, 1 ind., 3 m in depth, associated with sessile organism in subtidal area, Yullim-ri, Dolsan-eup, Yeosu-si, Jeollanam-do, Korea (34°35′35.5″N, 127°48′26.6″E), 23 June 2011, collected by Sun-Sang Hong and Nam-Hyuk Kim, fixed in 80% ethanol. NIBRIV0000801047, 1 ind., intertidal rocky area, associated with sessile organisms, Wangdeungeo, Yeonggwang-gun, Jeollanam-do Korea, 27 June 2007, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000165647, 1 ind., intertidal rocky area, associated with sessile organisms, Sulyeog-ri, Dundeok-myeon, Geoje-si, Gyeongsangnam-do, Korea (34°50′17″N, 128°29′24″E), 9 April 2009, collected by Kyung-Jin Lee, fixed in 80% ethanol. NIBRIV0000810283, 1 ind., Oemaemuldo Is., Ucheon-ri, Yeongnam-myeon, Goheung-gun, Jeollanam-do Korea, collected by Taeseo Park, fixed in 80% ethanol.

Diagnosis

Greenish brown colored dorsum in live specimens. Paragnath absent in area V; area VII–VIII with transverse row of larger paragnaths with densely continuous minute paragnaths on oral side. Noropodial prechaetal lobe and neuropodial postchaetal lobe absent throughout. Notopodial homogomph falcigers appear from chaetiger 18–21.

Description of atokes

Holotype, incomplete with 65 chaetigers, 2.1 mm and 3.3 mm wide excluding and including parapodia at chaetiger 10, respectively.

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum greenish brown color in live and preserved individuals.

Prostomium pyriform, slightly wider than long, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with palpophores and ovoid palpostyles. Two pairs of eyes arranged trapezoidally; gap of anterior pair slightly wider than posterior pair (Fig. 59A).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 3.

Proboscis with pair of brown amber jaws, each with 4 teeth of serrated inner margin (Fig. 59A, B). Conical paragnaths present on both maxillary and oral rings except area V. Paragnath numbers and arrangements in holotype as follows (range in other material given in parentheses): area I, 1 (1–3); area II, 12 (12–17) on left, 11 (11–17) on right, arranged in oblique rows; area III, 12 (11–18) without lateral groups; area IV, 15 (15–29) on left, 12 (12–29) on right, arranged in curved cluster, bar shaped paragnaths present on toward jaw (Figs. 59C, 63A-3); area V, none; area VI, 4 (4–6) on left, 6 (4–7) on right, arranged in a cluster; areas VII–VIII with transverse row of larger paragnaths with densely continuous minute paragnaths on oral side (Figs. 59A, B; 63A).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus.

In anterior parapodia (Fig. 59D, E), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule, twice longer than notopodial ventral ligules. Notopodial dorsal and ventral ligules cylindrical, notopodial ventral ligule longer than notopodial dorsal ligule; notopodial prechaetal lobes and notoacicular papillae absent. Neuroacicular ligules subconical, subequal to notopodial dorsal ligules, postchaetal lobes absent; neuropodial ventral ligules digitate, subequal to neuroacicular ones. Ventral cirri slightly shorter than neuropodial ventral ligules.

In middle parapodia (Fig. 59F, G), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule, more than four times longer than notopodial ventral ligules. Notopodial dorsal and ventral ligules subconical, subequal to each other, dorsal ligules slightly slender than ventral ones, notopodial prechaetal lobe and notoacicular papillae absent. Neuroacicular ligules subconical, wider than long, subequal to neuropodial ventral ligules, postchaetal lobes absent; neuropodial ventral ligules digitate. Ventral cirri longer than neuropodial ventral ligules, extending beyond their tips.

In posterior parapodia (Fig. 59H), dorsal cirri subterminally inserted, extending beyond notopodial dorsal ligule, more than three times longer than notopodial ventral ligules. Notopodial dorsal ligule reduced, subconical with tapering tip, subequal to ventral ligules; notopodial ventral ligules subconical with tapering tip, notopodial prechaetal lobe and notoacicular papilla absent. Neuroacicular ligules subconical, wider than long, postchaetal lobes absent; neuropodial ventral ligules digitate, half length of notopodial ventral ligules. Ventral cirri as long as neuropodial ventral ligules, not extending beyond their tips.

Notochaetae all homogomph spinigers in anterior parapodia, homogomph spinigers and falcigers in middle parapodia, all homogomph flacigers in posterior parapodia. Homogomph falcigers present from chaetiger 21 (18–21). Upper neurochaetae consisting of homogomph or sesquigomph spinigers and heterogomph falcigers throughout (Fig. 3A). Lower neurochaetae consisting of heterogomph spinigers and heterogomph falcigers throughout (Fig. 3A). Chaetae decreased in number toward posterior end.

Notopodial homogomph or sesquigomph spinigers with long serrated blades (Fig. 59M). Notopodial homogomph falcigers stout with rod-shaped blade (Fig. 59I). Neuropodial homogomph and heterogomph spinigers (Fig. 59L) with long serrated blades. Neuropodial heterogomph falcigers in anterior parapodia with serrated medium blades, distally incurved; in posterior parapodia stout with serrated short blades, distally incurved (Fig. 59J, K).

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers are summarized in Table 34.

Habitats

Both intertidal and subtidal rocky areas associated with sessile organisms.

Distribution

Type locality: Tongyoung-si, Korea. Korea (Southern coast) (Fig. 61).

Molecular data

The COI sequences obtained from five individuals (Table 4, Appendix 2).

Remarks

Nereis sp. nov. 3 is very similar to *N. multignatha* Imajima and Hartman, 1964. However, it clearly differs from *N. multignatha* in the following diagnostic characteristics:

(1) the presence of bar-shaped paragnaths in area IV (Figs. 59C, 63A-3), in contrast to the absence of those in *N. multignatha* (Fig. 63B-3), (2) the absence of paragnaths in area V (Figs. 59A, 63A-1, Table 37), in contrast to the presence or absence of those in *N. multignatha* (Figs. 62A, 63B-1, Table 37).

Comparisons of DNA sequences of COI between *N.* sp. nov. 3 and *N. multignatha* showed that they markedly differed from each other (mean p-distance: 0.157), supporting the conclusion of morphological analysis (Fig. 60, Table 33).

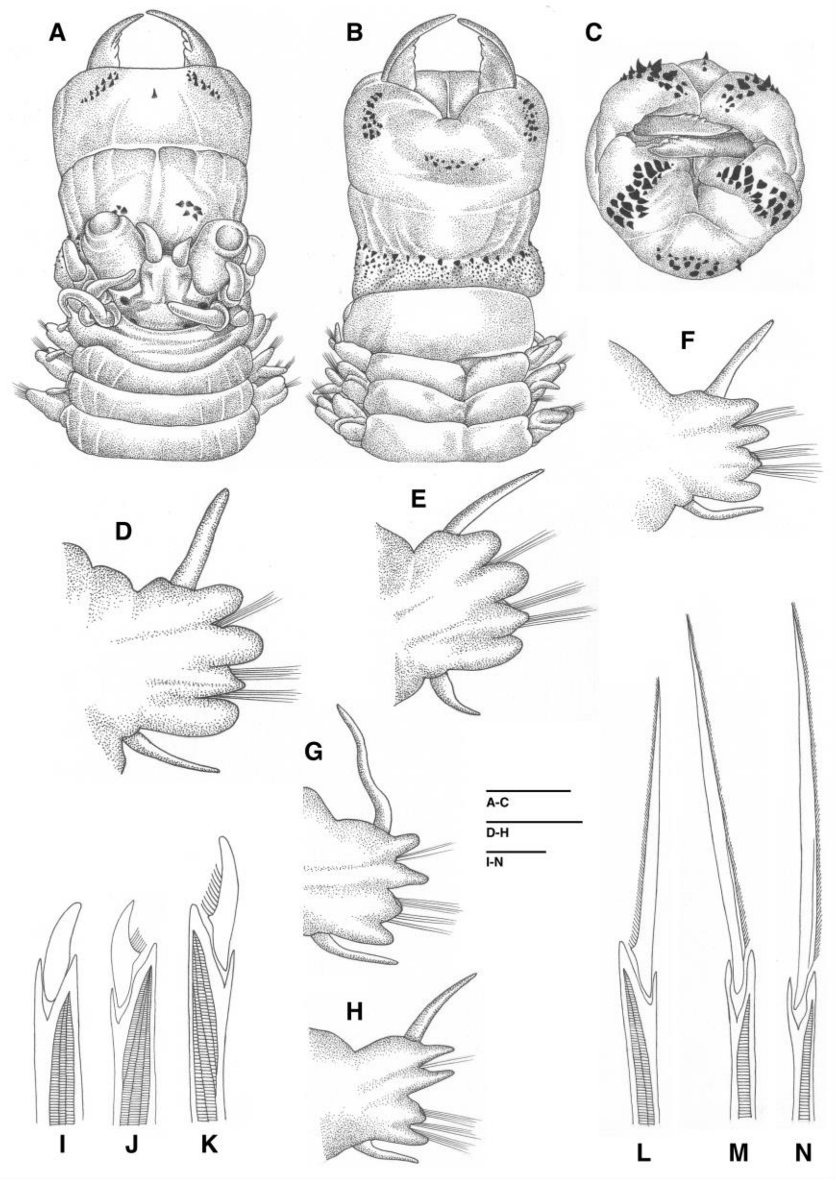

Fig. 59. *Nereis* sp. nov. 3, holotype, (A, B, D–N) NIBRIV0000783838; (C) non-type, NIBRIV0000783837. (A–C) Dorsal, ventral, and frontal views of anterior end with the everted proboscis. (D–H) Anterior views of parapodium 5 (D); 9 (E); 18 (F); 37 (G); (H) 54. (I) Homogomph falciger from notochaetae in parapodium 37. (J) Heterogomph falciger from lower neurochaetae in parapodium 37. (K) Heterogomph falciger from lower neurochaetae in parapodium 9. (L) Heterogomph spiniger from lower neurochaetae in parapodium 9. (M) Sesquigomph spiniger from notochaetae in parapodium 9. (N) Sesquigomph spiniger from upper neurochaetae in parapodium 5. Scale bars: 1 mm in (A–C); 0.5 mm in (D–H); 0.02 mm in (I–N).

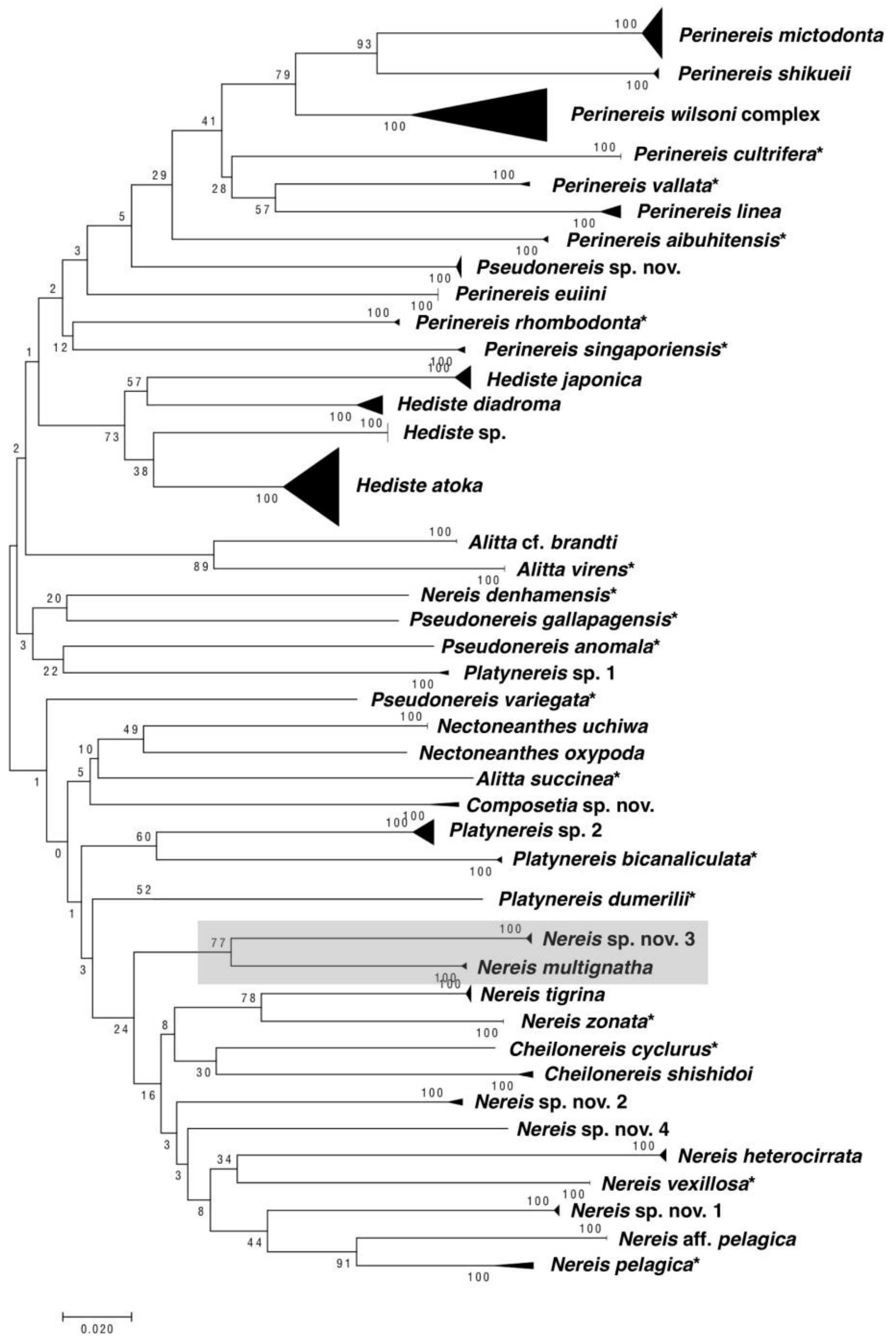

Fig. 60. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray box represents the difference between *Nereis* sp. nov. 3 and *N. multignatha* Imajima and Hartman, 1964.

Table 33. Mean pairwise genetic distances (K2P distance) based on COI sequences between *Nereis* sp. nov. 3 and *N. multignatha* Imajima and Hartman, 1964. n = individuals.

Species	*N.* sp. nov. 3	*N. multignatha*
N. sp. nov. 3 (n=5)	0.001	0.157
N. multignatha (n=7)	0.157	0.001

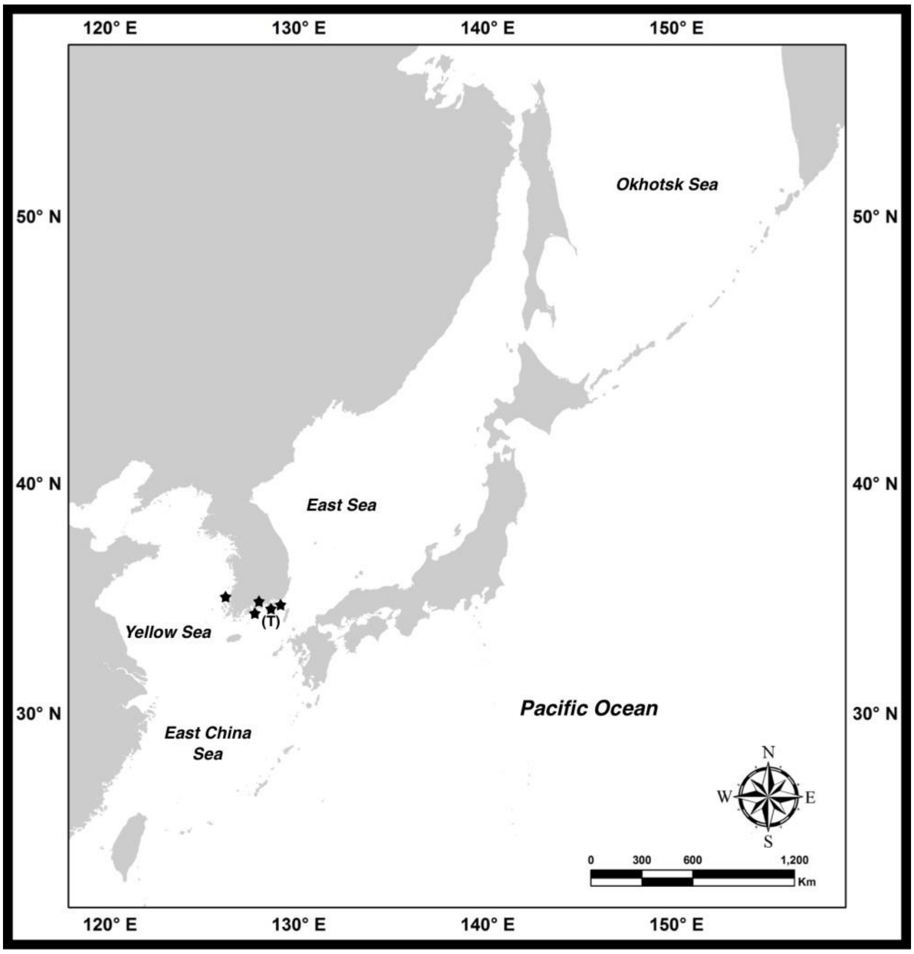

Fig. 61. Distribution of *Nereis* sp. nov. 3 in Northeast Asia based on the present study (★). (T) Type locality.

Table 34. Variation in paragnath number in area I to VI on proboscis of *Nereis* sp. nov. 3. Ranges (mean ± standard deviation) are shown. L: left side, R: right side.

Locality	**I**	**II(L)**	**II(R)**	**III**	**IV(L)**	**IV(R)**	**V**	**VI(L)**	**VI(R)**
Korea (n=7) (Present study)	1–3 (1.9±0.9)	12–17 (14.6±2)	11–17 (14.7±2.1)	11–18 (14.7±2.9)	15–29 (22.9±4.4)	12–29 (23±5.7)	none	4–6 (5.1±0.9)	4–7 (5.1±1.1)

15. ***Nereis multignatha*** **Imajima and Hartman, 1964 (Figs. 62–67)**

Nereis pelagica multignatha Imajima and Hartman,1964: 148–149.

Nereis multignatha: Imajima, 1972: 136–138, figs. 45a–k, 51; 1996: 156, fig. 122a–i; Paik, 1975, 414–415, pl. 5, figs. 35–43; 1977: 185–187, fig. 22; 1982: 788, pl. 13j–l; Wu et al., 1985: 114–117, figs. 63A–I, 64A–F.

Nereis pelagica: Izuka, 1912: 154–156, pl. 17, figs. 1–6.

Nereis neoneanthes: Imajima and Hayashi, 1969: 10, pl. 1, figs. a–m; Imajima, 1972: 133–135, figs. 30a–m, 51; 1996: 154–155, figs. 121a–i, 121'a–f; 2003: 173; Paik, 1975: 413–414, pl. 4, figs. 25–34; 1977: 182–185, fig. 21; 1982: 788, pl. 13g–i; 1989: 324–326, pls. 28, 29, fig. 70(1–3), text fig. 80A–C; Wu et al., 1985: 99–101, figs. 52A–I, 53A–E.

Materials examined

Non-type materials

NIBRIV0000783840, 1ind., 8 m in depth, associated with sessile organism in subtidal rocky area, White Rock point in Aqua gallery dive resort, Namae-ri, Yangyang-gun, Gangwon-do, Korea (37°56′8″N, 128°47′39″E), 11 June 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783841, 1 ind.; NIBRIV0000787899, 9 inds.; NIBRIV0000783815, 2 inds.; NIBRIV0000783842, 1 ind., 8 m in depth, associated with sessile organism in subtidal rocky area, White Rock point in Aquagallery dive resort, Namae-ri, Yangyang-gun, Gangwon-do, Korea (37°56′8″N, 128°47′39″E), 11 June 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783816, 1 ind., 8 m in depth, associated with sessile organism in subtidal rocky area, White Rock point in Aquagallery dive resort, Namae-ri, Yangyang-gun, Gangwon-do, Korea (37°56′8″N, 128°47′39″E), 10 June 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000810294, 6 inds.; NIBRIV0000810285, 1 ind., associated with algal roots in intertidal rocky area, Oeseodo Is., Yeosu-si, Jeollanam-do, Korea (34°32′29″N, 127°41′15″E), 12 June 2012, collected by Haeng-Pil Lee and Dae-Seong An, fixed in 80% ethanol. NIBRIV0000810284, 4 inds., 15 m in depth, associated with sessile organism in subtidal rocky area, Wangdolcho Reef, Uljin-gun, Gyungsangbuk-do, Korea, 14 August 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783843, 12 inds.; NIBRIV0000783817, 2 inds., 3 m in depth, associated with sessile organisms in subtidal rocky area, Geomundo Is., Yulchon Wharf, Seodo-ri, Yeosu-si, Jeollanam-do, Korea (34°3′20″N, 127°17′36″E), 24 April 2013, collected by Taeseo Park, Seul Yi, Sang-Hwi Lee.

Comparative materials

Holotype of *Nereis neoneanthes* Hartman, 1948, (USNM 20918), Off Moffet Point, Alaska, Bering Sea, USA, 1 June 1941, collected by W. L. Schmit.

Diagnosis

Greenish brown colored dorsum in live specimens. Bar shaped paragnaths absent in area IV, paragnath absent or present in area V; area VII–VIII with transverse row of larger paragnaths with densely continuous minute paragnaths on oral side. Noropodial prechaetal lobe and neuropodial postchaetal lobe absent throughout. Notopodial homogomph falcigers appear from chaetiger 16–19.

Description of atokes

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum greenish brown color in live and preserved individuals.

Prostomium pyriform, slightly wider than long, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with palpophores and ovoid palpostyles. Two pairs of eyes arranged trapezoidally; gap of anterior pair slightly wider than posterior pair (Figs.

62A, 63B-1).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 3 (Figs. 62A, B; 63B-1–2).

Proboscis with pair of brown amber jaws, each with 4 teeth of serrated inner margin. Conical paragnaths present on both maxillary and oral rings except area V, paragnaths on area V absent or present. Paragnath numbers and arrangements as follows: area I, 2–4; area II, 9–25 on left, 11–19 on right, arranged in oblique rows; area III, 13–32 without lateral groups; area IV, 15–33 on left, 13–33 on right, arranged in curved cluster, bar shaped paragnaths absent (Figs. 62B, 63B-3); area V, 0–7; area VI, 4–22 on left, 4–17 on right, arranged in a cluster; areas VII–VIII with transverse row of larger paragnaths with densely continuous minute paragnaths on oral side (Figs. 62A, B; 63B; 64B; Table 36).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus (Fig. 62C).

In anterior parapodia (Fig. 62D), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule, more than three times longer than notopodial ventral ligules. Notopodial dorsal and ventral ligules cylindrical, notopodial ventral ligule longer than notopodial dorsal ligule; notopodial prechaetal lobes and notoacicular papillae absent. Neuroacicular ligules subconical, subequal to notopodial dorsal ligules, postchaetal lobes absent; neuropodial ventral ligules digitate, subequal to neuroacicular ones. Ventral cirri slightly shorter than neuropodial ventral ligules.

In middle parapodia (Fig. 62E, F), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule, more than four times longer than notopodial ventral ligules. Notopodial dorsal and ventral ligules subconical, subequal to each other, dorsal ligules slightly slender than ventral ones, notopodial prechaetal lobe and notoacicular papillae absent. Neuroacicular ligules subconical, wider than long, subequal to neuropodial ventral ligules, postchaetal lobes absent; neuropodial ventral ligules digitate. Ventral cirri longer than neuropodial ventral ligules, extending beyond their tips.

In posterior parapodia (Fig. 62G), dorsal cirri subterminally inserted, extending beyond notopodial dorsal ligule, more than three times longer than notopodial ventral ligules. Notopodial dorsal ligule reduced, subconical with tapering tip, subequal to ventral ligules; notopodial ventral ligules subconical with tapering tip, notopodial prechaetal lobe and notoacicular papilla absent. Neuroacicular ligules subconical, wider than long, postchaetal lobes absent; neuropodial ventral ligules digitate, half length of notopodial ventral ligules. Ventral cirri as long as neuropodial ventral ligules, not extending beyond their tips.

Notochaetae all homogomph or sesquigomph spinigers in anterior parapodia, homogomph or sesquigomph spinigers and falcigers in middle parapodia, all homogomph falcigers in posterior parapodia. Homogomph falcigers present from chaetiger 18 (16–19). Upper neurochaetae consisting of homogomph or sesquigomph spinigers and heterogomph falcigers throughout. Lower neurochaetae consisting of heterogomph spinigers and heterogomph falcigers throughout (Fig. 63H–K). Chaetae decreased in number toward posterior end.

Notopodial homogomph or sesquigomph spinigers with long serrated blades (Fig. 62H). Notopodial homogomph falcigers stout with rod-shaped blade (Fig. 62K). Neuropodial homogomph and heterogomph spinigers (Fig. 62I) with long serrated blades. Neuropodial heterogomph falcigers in anterior parapodia with serrated medium blades, distally incurved; in posterior parapodia stout with serrated short blades, distally incurved (Fig. 62J).

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers are summarized in Table 36.

Habitats

Subtidal rocky area associated with sessile organisms.

Distribution

Type locality: Japan. China, Japan, Korea (Fig. 66).

Molecular data

The COI sequences obtained from seven individuals (Table 4, Appendix 2).

Remarks

Izuka (1912) reported *Nereis pelagica* Linnaeus, 1758 from Japan. Imajima and Hartman (1964) regarded Izuka (1912)'s specimens as a new subspecies of *Nereis pelagica multignatha* different from stem species of *N. pelagica*. Later, Imajima (1972) treated this subspecies as a distinct species of *N. multignatha*. Subsequently, *N. neoneanthes* Hartman, 1948 (type locality: Alaska, USA) was reported by Imajima and Hayashi (1969) from Japan.

According to Imajima (1972), *N. multignatha* and *N. neoneanthes* from Japan are extremely close to each other. However, they can be distinguished in that paragnaths on area V of the proboscis are in the former but present in the latter.

However, the present study demonstrates that Northeast Asian specimens (except specimens of Uschakov, 1965 from Far East Russia) previously reported as "*N. neoneanthes*" are different from *N. neoneanthes* based on morphological comparison with type specimen of *N. neoneanthes*. *Nereis multignatha* differs from the type specimen of *N. neoneanthes* in the following diagnostic characteristics: (1) the presence of densely continuous minute paragnaths on oral side in area VII–VIII (Fig. 64B-3, Table 37), in contrast to the presence of regular paragnaths in area VII–VIII in the type specimen of *N. neoneanthes* (Fig. 64A-3, Table 37), (2) presence of notopodial homogomph falcigers from chaetigers 16–19, in contrast to presence of those from chaetiger 40 in the type specimen of *N. neoneanthes*, and (3) notopodial dorsal ligules are not expanded posteriorly (Fig. 64E, F, Table 37), in contrast to expanded posteriorly (up to two times longer than notopodial ventral ligule) in the type specimen of *N. neoneanhtes* (Fig. 64C, D, Table 37).

Additionally, comparisons of COI DNA sequences between *N. multignatha* and Northeast Asian specimens of "*N. neoneanthes*" are identical (Fig. 67, Table 35). Therefore, it can be concluded that all specimens previously reported as "*N. neoneanthes*" from Northeast Asian waters, i.e., China, Japan, and Korea (Imajima and Hayashi, 1969; Imajima, 1972, 1996; Paik, 1975, 1977, 1982, 1989; Wu et al., 1985) are not *N. neoneanthes sensu stricto,* but *N. multignatha*. Their aberrant paragnath number in area V is intraspecific variation of *N. multignatha* (Fig. 65).

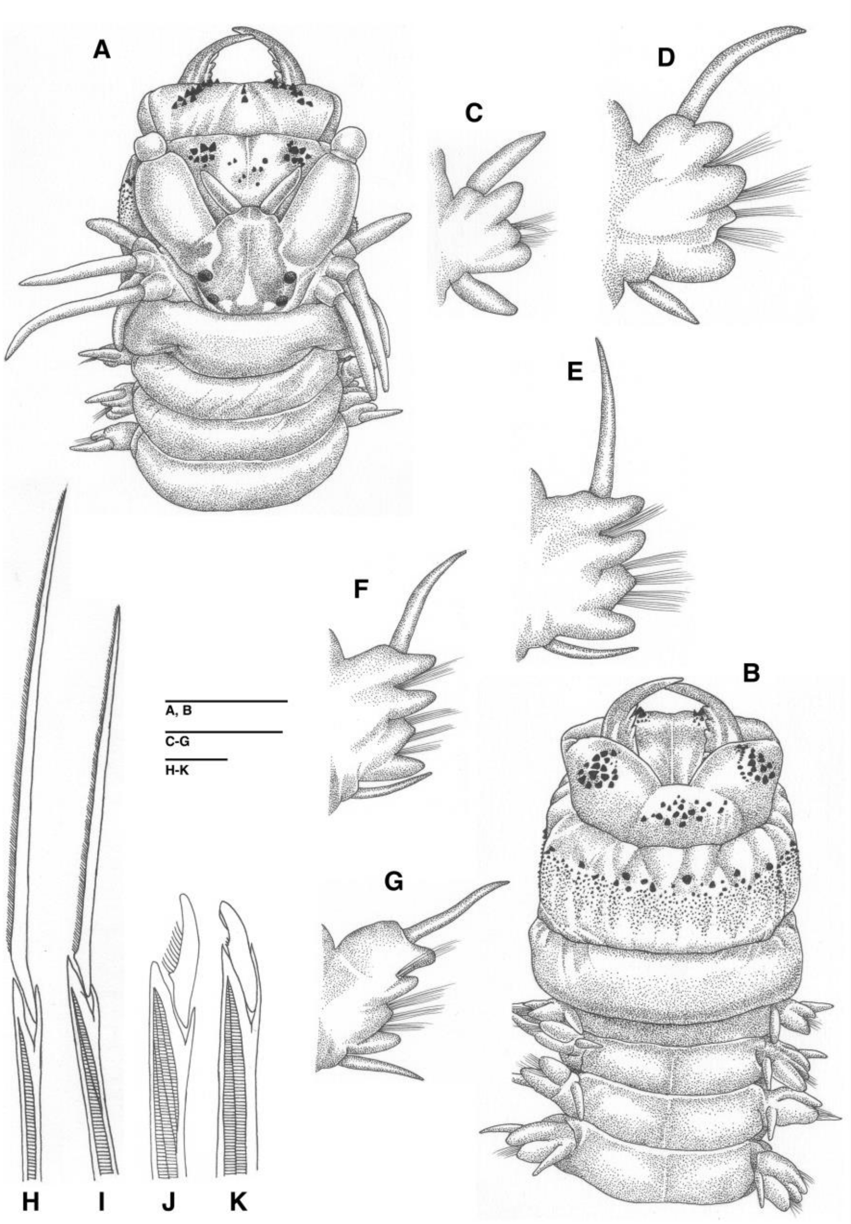

Fig. 62. *Nereis multignatha* Imajima and Hartman, 1964, NIBRIV0000783840. (A, B) Dorsal and ventral views of anterior end with the everted proboscis. (C–G) Anterior views of parapodium 1 (C); 8 (D); 22 (E); 41 (F); (G) 56. (H) Sesquigomph spiniger from notochaetae in parapodium 22. (I) Heterogomph spiniger from lower neurochaetae in parapodium 8. (J) Heterogomph falciger from upper neurochaetae in parapodium 40. (K) Homogomph falciger from notochaetae in parapodium 44. Scale bars: 2 mm in (A, B); 1 mm in (C–G); 0.02 mm in (H–K).

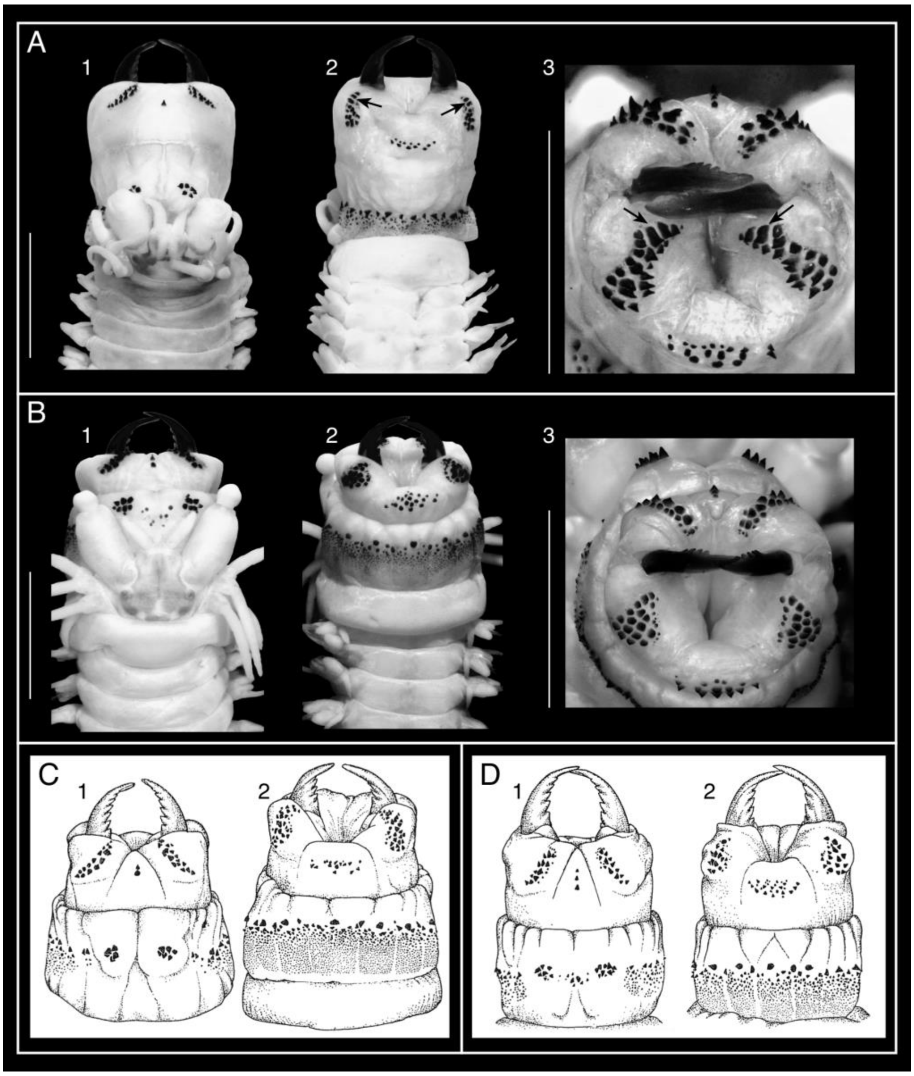

Fig. 63. Dorsal, ventral, and frontal views of everted proboscis of *Nereis* sp. nov. 3 and *N. multignatha* Imajima and Hartman, 1964. (A) *N.* sp. nov. 3: (1) dorsal view of holotype; (2) ventral view of holotype; (3) frontal view of non-type (NIBRIV0000783837). (B) *N. multignatha* (NIBRIV0000783840): (1) dorsal view; (2) ventral view; (3) frontal view. (C) *N. multignatha sensu* Imajima, 1972 (modified from Imajima, 1972): (1) dorsal view; (2) ventral view. (D) *N. neoneanthes sunsu* Imajima, 1972 (modified from Imajima, 1972): (1) dorsal view; (2) ventral view. Arrows indicate bar-shaped paragnaths on area IV. Scale bars, 2 mm.

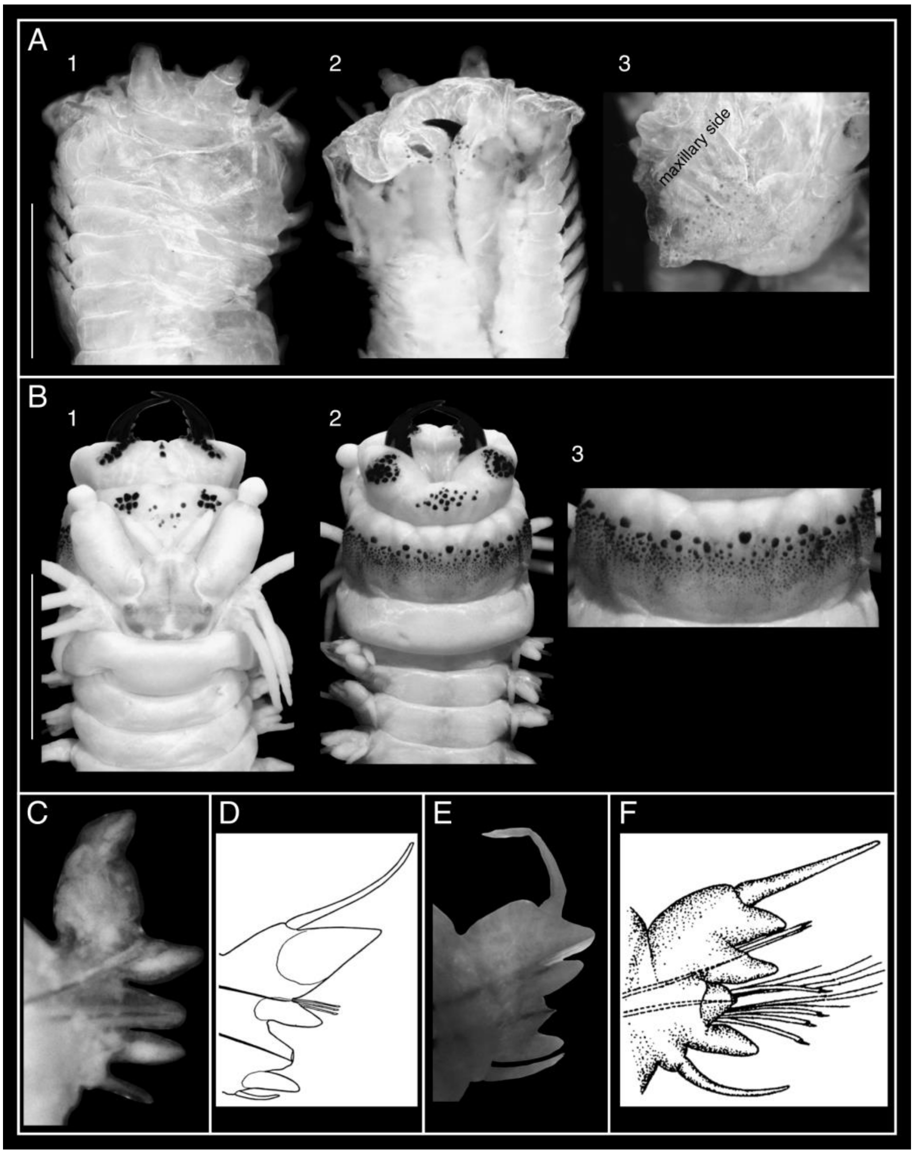

Fig. 64. Dorsal and ventral views of everted proboscis, and anterior view of posterior parapodia of *Nereis neoneanthes* Hartman, 1948 and *N. multignatha* Imajima and Hartman, 1964. (A) *N. neoneanthes* (holotype, USNM 20918): (1) dorsal view; (2) ventral view; (3) paragnaths on area VII–VIII. (B) *N. multignatha* (NIBRIV0000783840): (1) dorsal view; (2) ventral view; (3) paragnaths on area VII–VIII. (C, D) *N. neoneanthes* (holotype, USNM 20918): (C) posterior parapodium; (D) posterior parapodium (modified from Hartman, 1948). (E) *Nereis multignatha* (NIBRIV0000783840), posterior parapodium. (F) *Nereis neoneanthes sensu* Imajima, 1972, posterior parapodium (modified from Imajima, 1972). Scale bars, 2 mm.

Table 35. Mean pairwise genetic distances (K2P distance) based on COI sequences between *Nereis multignatha* Imajima and Hartman, 1964 and "*N. neoneanthes* Hartman, 1948" from Northeast Asia. n = individuals.

Species	*N. multignatha*	"*N.* neoneanthes" from Northeast Asia
N. multignatha (n=6)	0.000	0.003
"*N.* neoneanthes" from Northeast Asia (n=1)	0.003	-

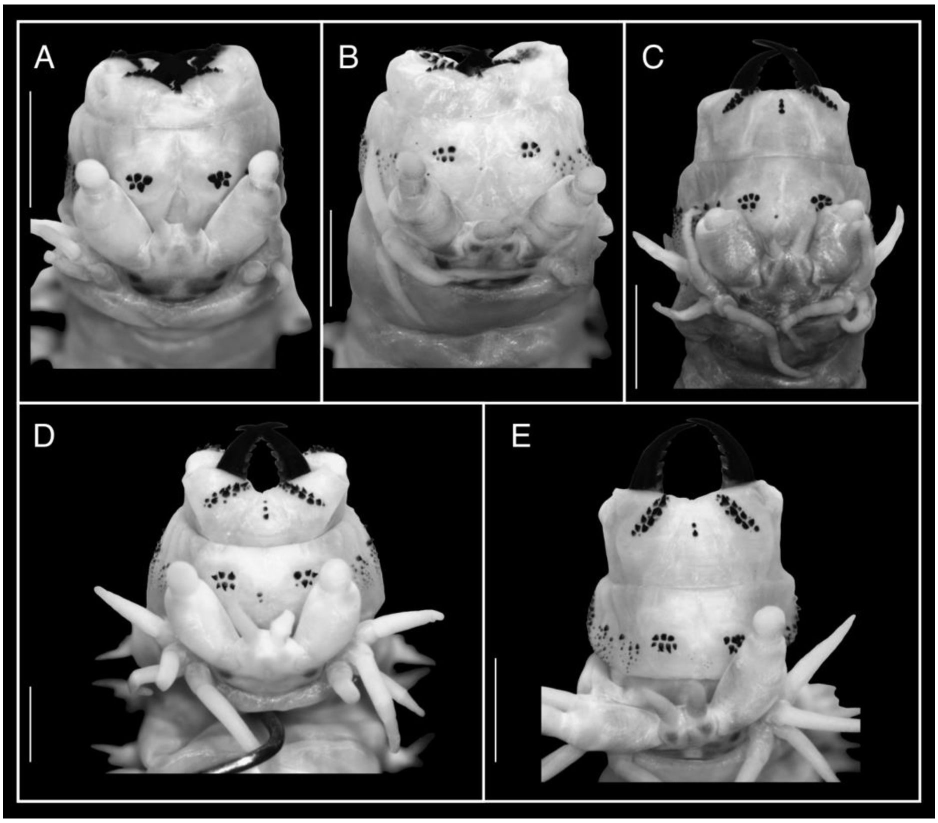

Fig. 65. Variation of paragnath number on area V of *Nereis multignatha* Imajima and Hartman, 1964. (A) NIBRIV0000783815. (B) NIBRIV0000783842, (C) NIBRIV0000783816, (D, E) NIBRIV0000783817. Scale bars, 2 mm.

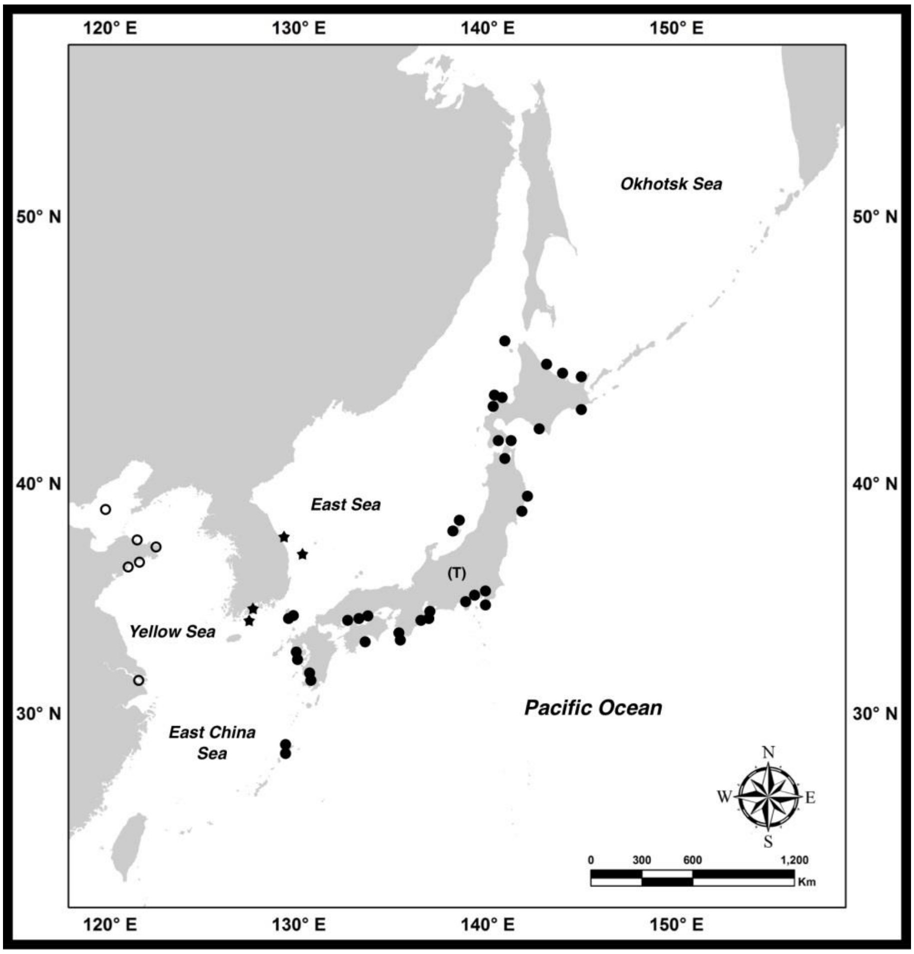

Fig. 66. Distribution of *Nereis multignatha* Imajima and Hartman, 1964 in Northeast Asia based on the present study (★) and the literature. (●) Imajima (1972), (○) Wu et al. (1985). (T) Type locality.

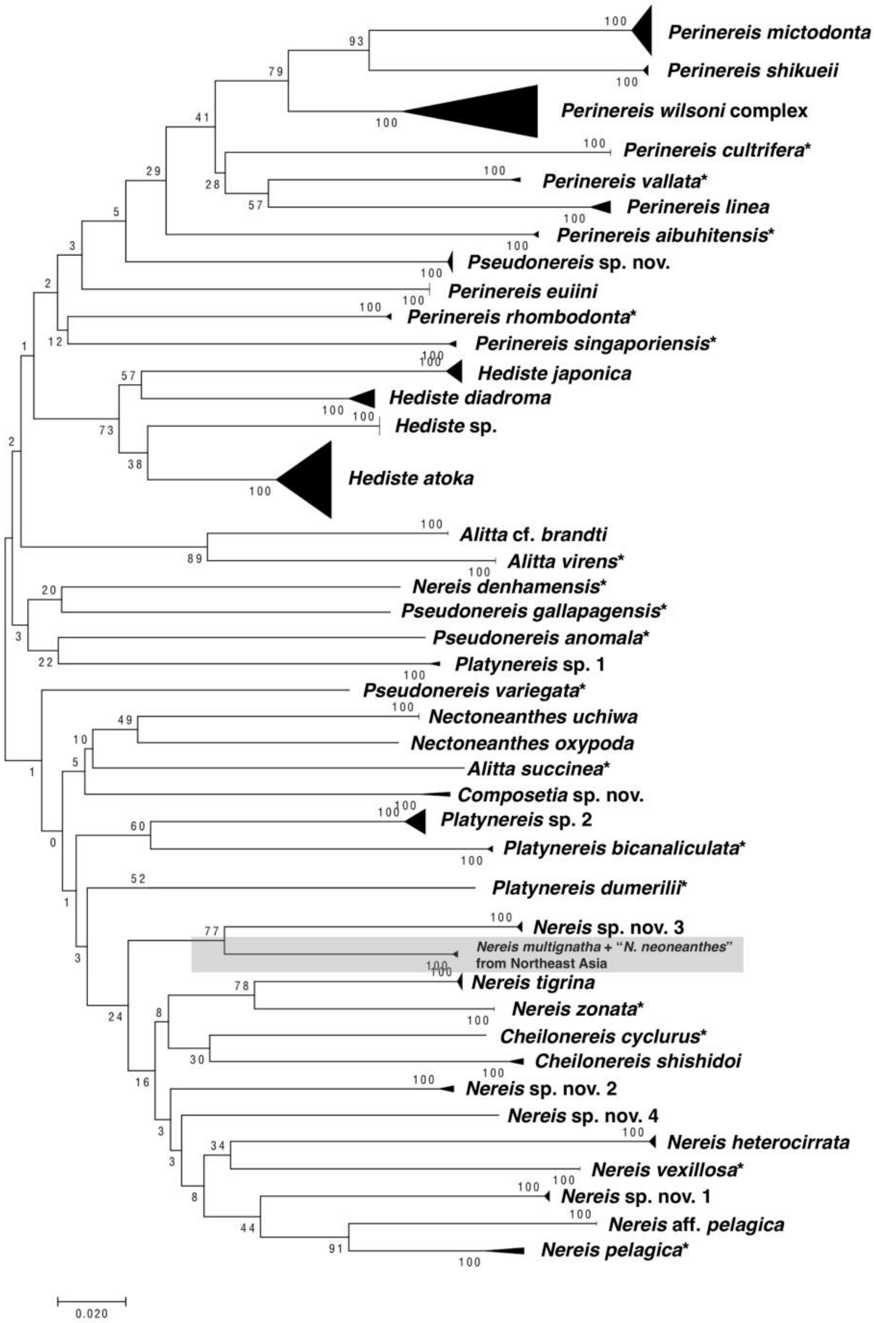

Fig. 67. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. *Nereis multignatha* Imajima and Hartman, 1964 and "*N. neoneanthes* Hartman, 1948" from Northeast Asia represented by a single clade in gray box.

Table 36. Variation in paragnath number in area I to VI on proboscis of *Nereis multignatha* Imajima and Hartman, 1964. Ranges (mean ± standard deviation) are shown. L: left side, R: right side.

Locality	I	II(L)	II(R)	III	IV(L)	IV(R)	V	VI(L)	VI(R)
Korea (n=33) (Present study)	2–4 (2.6±0.7)	9–25 (16.1±3)	11–19 (15.8±2.4)	13–32 (18.7±4.3)	15–33 (22±4.1)	13–33 (22.3±4.4)	0–7 (2.2±2)	4–22 (10.2±4.2)	4–17 (9.5±3.4)
Japan (n=?) (Imajima 1972)	2–3	16–17		about 20	33–36		none	5–6	
Japan (n=?) (Imajima 1972, as *N. neoneanthes*)	2–5	17–34		17–28	23–32		2–18	10–13	
China (n=?) (Wu et al., 1985)	1–3	20–25		20–24	25–28		none	7–10	
China (n=?) (Wu et al., 1985, as *N. neoneanthes*)	1–3	13–18		18–24	22–28		5–10	10–13	

Table 37. Comparison of key characteristics of *Nereis multignatha* Imajima and Hartman, 1964 with closely similar species.

Species (Locality and reference)	Range of paragnath number								Notopodial homogomph falciger	Posterior notopodial dorsal ligule
	I	II*	III	IV*	IV (Bars)	V	VI*	VII–VII		
N. multignatha (n=33) (Korea, present study, type and non-types)	2–4	9–25	13–32	13–33	absent	0–7 (absent or present)	4–22	single row of larger paragnaths with densely continuous minute paragnaths on oral side	from chaetiger 16–19	not expanded
N. sp. nov. 3 (n=7) (Korea, present study, type and non-types)	1–3	11–17	11–18	12–29	present	absent	4–7	single row of larger paragnaths with densely continuous minute paragnaths on oral side	from chaetiger 18–21	not expanded
N. neoneanthes (Alaska, present study and Hartman, 1948, holotype)	1	4–5	about 18	about 14	absent	3	6–8	paragnath cover most of oral ring (without densely continuous minute paragnath on oral side)	from chaetiger 40	expanded up to 2 times longer than notopodial ventral ligule

*Paragnath numbers on each side.

16. *Nereis* sp. nov. 4 (Figs. 68–71)

Nereis vexillosa: Imajima, 1972: 138–142, figs. 46a–m, 47a–d; 1996: 158–159, figs. 124a–k, 124'a–d; Paik, 1977: 189–191, fig. 24A–G; 1982: 788, pl. 13p–r; Wu et al., 1985: 117–120, figs. 65A–J, 66A–E.

Materials examined

Type materials

Holotype, NIBRIV0000810286, under boulder in intertidal area, Socheongdo Is., Bunbawi, Socheong-ri, Daecheong-myeon, Ongjin-gun, Incheon-si, Korea, 14 May 2017, collected by Kwang-Soo Kim, fixed in 80% ethanol.

Non-type materials

NIBRIV0000810324, 8 inds., under boulder in intertidal area, Socheongdo Is., Bunbawi, Socheong-ri, Daecheong-myeon, Ongjin-gun, Incheon-si, Korea, 14 May 2017, collected by Kwang-Soo Kim, fixed in 80% ethanol.

Comparative materials

Syntype of *Nereis vexillosa* Grube, 1851 (ZMB Q4069), 1 of 2 inds., Sitcha, Alaska, USA, collected by Middendorff, no further data. Syntype of *Nereis vexillosa* Grube, 1851 (ZMB Q4070), 2 inds., Ochotskisches Meer, North Pacific Ocean, no further data. Syntype of *Nereis vexillosa* Grube, 1851 (ZMB Q4068), 1 of 2 inds., Alaska and San Francisco, USA, collected, no further data. Topotype of *Nereis vexillosa* Grube, 1851 (USNM15802), Bering Sea, Alaska, USA, 2 July 1893, 1 ind., collected by United States Fish Commission. Non-type of *Nereis vexillosa* (NSMT-Pol 14130–14139), 9 inds., Akkeshi, Hokkaido, Japan (43°1.2′N, 144°50.5′E), July 1933, collected by Minoru Imajima.

Diagnosis

Whitish green or brownish cream colored dorsum in live specimens. Paragnath present or absent in area I; paragnath absent in area V. Heterogomph falcigers on upper neurochaetae present from middle chaetigers; homogomph falcigers on notochaetae present from posterior chaetigers. Notoacicular papilla present in anterior and middle parapodia; notopodial dorsal ligule gradually expanded posteriorly.

Description of atokes

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum whitish green or brownish cream color in live individuals, pale cream color in preserved ones.

Prostomium pyriform, slightly longer than wide, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with thick palpophores and round palpostyles. Two pairs of eyes arranged trapezoidally; gap of anterior pair slightly wider than posterior pair (Fig. 68A).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 6 (4–6) (Fig. 68A).

Proboscis with pair of dark brown amber jaws, each with 5–6 teeth of serrated inner margin. Conical paragnaths present on both maxillary and oral rings except area V. Paragnath numbers and arrangements in holotype as follows (range in other material given in parentheses): area I, 0 (0–3); area II, 23 (19–27) on left, 21 (18–25) on right, arranged in three rows; area III, 29 (22–33) in four irregular transverse rows with lateral groups; area IV, 37 (15–37) on left, 37 (18–50) on right arranged in curved cluster; area V, none; area VI, 7 (4–7) on left, 4 (3–6) on right; areas VII–VIII, 115 (102–128), single row of larger paragnaths with small paragnath on oral side (Figs. 68A–C; 69A, B; Table 39).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus (Fig. 68D).

In anterior parapodia (Fig. 68E), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule, twice longer than notopodial ventral ligules. Notopodial dorsal ligules oval with tapering tips, slightly longer than ventral ones; notopodial prechaetal lobes absent; notopodial ventral ligules oval with bluntly tapering tips, notoacicular papillae present. Neuroacicular ligules shortly globose, postchaetal lobes absent; neuropodial ventral ligules cylindrical, subequal to neuroacicular ones. Ventral cirri subequal to neuropodial ventral ligules, not extending beyond their tips.

In middle parapodia (Fig. 68F), dorsal cirri sub-terminally inserted, extending beyond notopodial dorsal ligule, more than twice longer than notopodial ventral ligules. Notopodial dorsal ligules expanded, notopodial ventral ligules subconical, notoacicular papillae present. Neuroacicular ligules subconical, subequal to neuropodial ventral ones, postchaetal lobes absent; neuropodial ventral ligules digitate. Ventral cirri subequal to neuropodial ventral ligules, not extending beyond their tips.

In posterior parapodia (Figs 68G, H), dorsal cirri terminally inserted, extending beyond notopodial dorsal ligule, three times longer than notopodial ventral ligules. Notopodial dorsal ligules subrectangular, greatly expanded; notopodial ventral ligules subconical, slightly longer than neuropodial ventral ones, notoacicular papilla absent. Neuroacicular ligules subconical, postchaetal lobes absent; neuropodial ventral ligules digitate, subequal to neuroacicular ligules. Ventral cirri slightly shorter than neuropodial ventral ligules, not extending beyond their tips.

Notochaetae all homogomph spinigers in anterior and middle parapodia, homogomph spinigers and falcigers in mid-posterior parapodia, all homogomph falcigers in posterior parapodia. Upper neurochaetae consisting of homogomph spinigers and heterogomph falcigers throughout. Lower neurochaetae consisting of heterogomph falcigers in anterior parapodia, heterogomph spinigers and falcigers in middle and posterior parapodia (Fig. 68I–N). Chaetae decreased in number toward posterior end.

Notopodial homogomph spinigers with long serrated blades (Fig. 68M). Notopodial homogomph falcigers stout with rod-shaped blade (Fig. 68K). Neuropodial homogomph or sesquigomph, and heterogomph spinigers with long serrated blades (Fig. 68J, N). Neuropodial heterogomph falcigers stout with serrated blades, distally incurved (Fig. 68I, L).

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers are summarized in Table 39.

Habitats

Intertidal and shallow subtidal zones. Associated with sessile organisms or under boulder.

Distribution

Type locality: Korea (Baeklyungdo Is.) China, Japan, Korea (Fig. 70).

Remarks

Nereis sp. nov. 4 is similar to *N. vexillosa* Grube, 1851 (type locality: Alaska and Siberia, Pacific Ocean) in terms of the presence of broad paragnath band VII–VIII and the presence of elongated notopodial dorsal ligules in posterior parapodia.

However, it clearly differs from *N. vexillosa* in the following diagnostic characteristics: (1) the presence of lateral groups of paragnaths in area III (Fig. 69B, Table 40), in contrast to the absence of those in *N. vexillosa* (Fig. 69F, H; Table 40), (2) the number of paragnath in areas II–IV is fewer in *N.* sp. nov. 4 than that in *N. vexillosa* (Table 40).

Morphological characteristics of specimens previously reported as *N. vexillosa* from China, Japan, and Korea (Imajima, 1972, 1996; Paik, 1977, 1982; Wu et al., 1985) agreed well with those of *N*. sp. nov. 4 (Fig. 69C, D; Table 39). Therefore, it is concluded that they all belong to *N*. sp. nov. 4.

This conclusion based on morphological analysis is supported by comparison of DNA sequences of COI between *N*. sp. nov. 4 and *N. vexillosa* from Canada. DNA sequences of specimens from Canada significantly differed from those of *N*. sp. nov. 4. (mean p-distance: 0.205) (Fig. 71, Table 38), indicating that Canada specimens belong to *N. vexillosa sensu stricto* whereas Northeast Asian specimens belong to *N*. sp. nov. 4, not *N. vexillosa*.

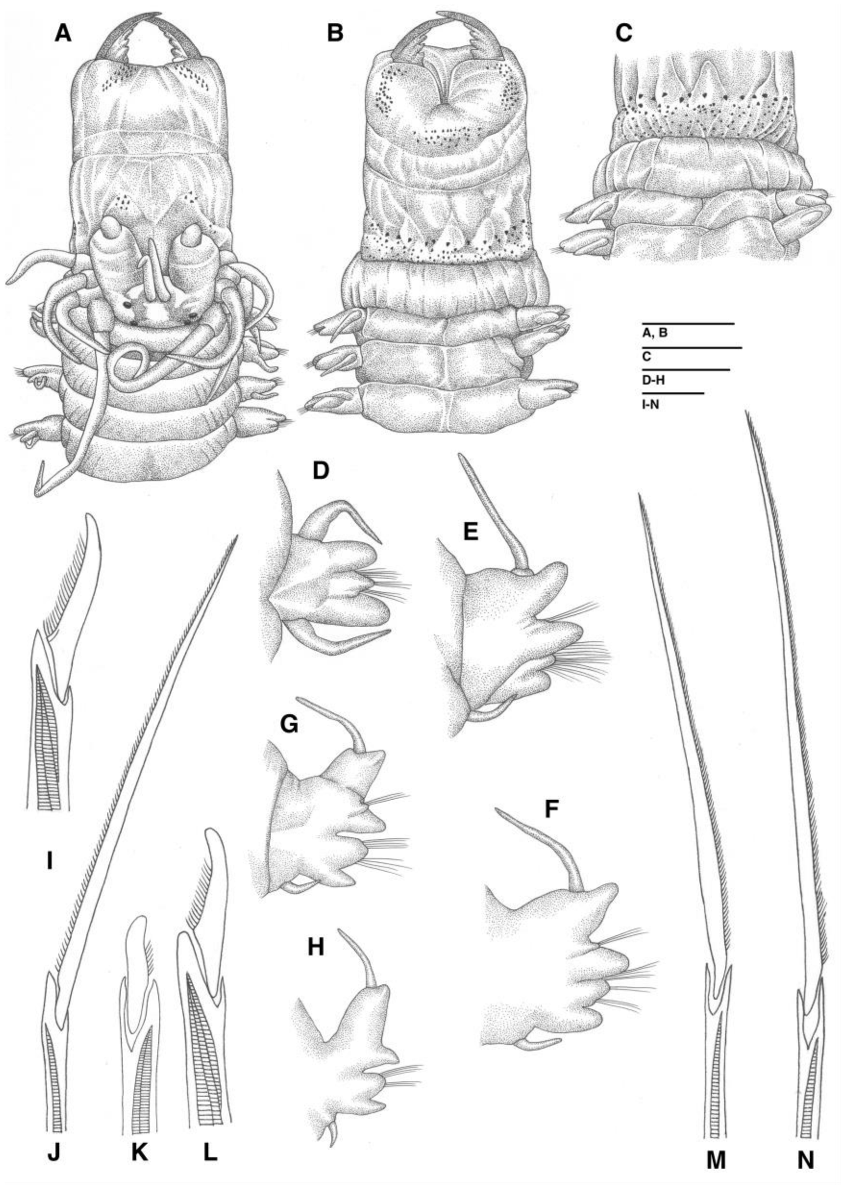

Fig. 68. *Nereis* sp. nov. 4, holotype, NIBRIV0000810286. (A, B) Dorsal and ventral views of anterior end with the everted proboscis. (C) Enlarged ventral view of proboscis. (D–H) Anterior views of parapodium 1 (D); 12 (E); 22 (F); 40 (G); 55 (H). (I) Heterogomph falciger from lower neurochaetae in parapodium 10. (J) Heterogomph spiniger from lower neurochaetae in parapodium 30. (K) Homogomph falciger from notochaetae in parapodium 40. (L) Heterogomph falciger from upper neurochatae in parapodium 30. (M) Homogomph spiniger from notochaetae in parapodium 30. (N) Sesquigomph spiniger from upper neurochaetae in parapodium 10. Scale bars: 1 mm in (A–H); 0.02 mm in (I–N).

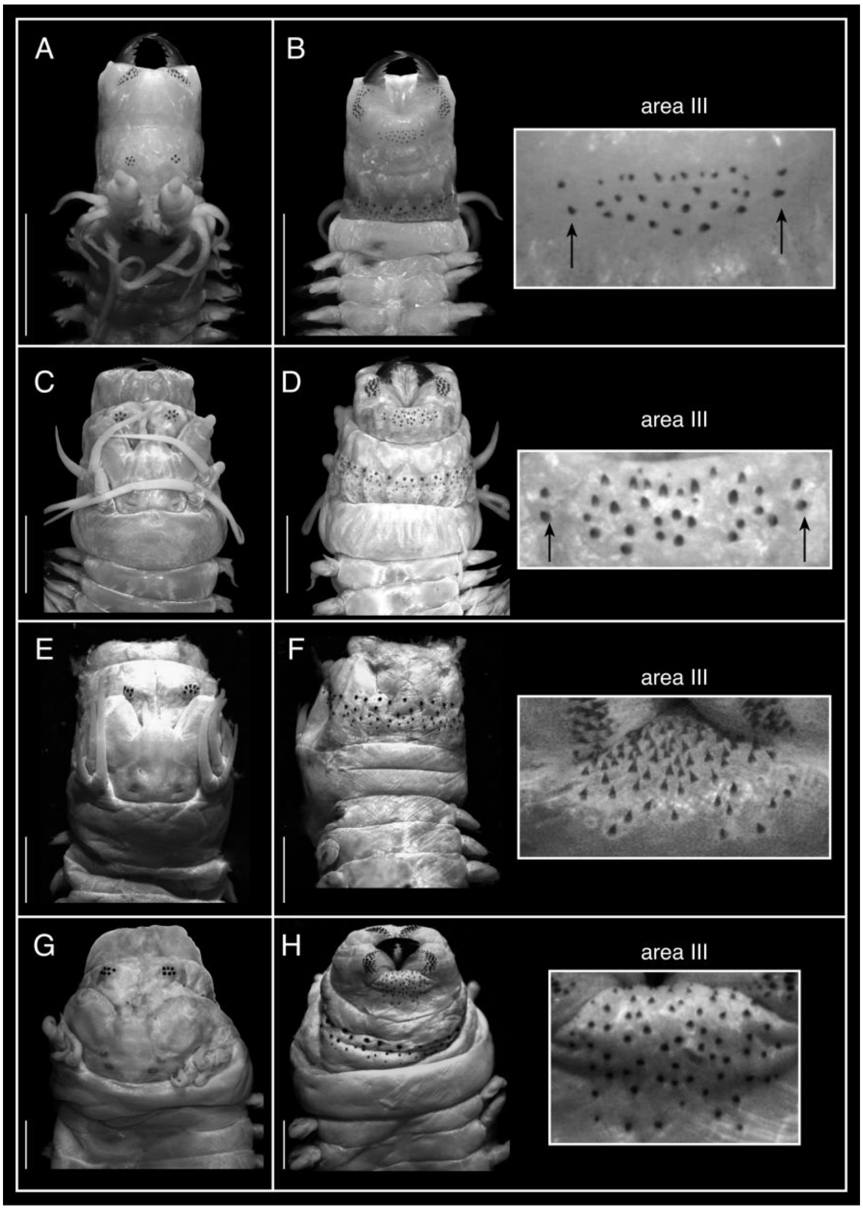

Fig. 69. Dorsal and ventral views of everted proboscis of *Nereis* sp. nov. 4 and *N. vexillosa* Grube, 1851. (A, B) *N.* sp. nov. 4: (A) dorsal view of holotype; (B) ventral view of holotype. (C, D) Nontype of *N. vexillosa* (NSMT-Pol 14130–14139): (C) dorsal view; (D) ventral view. (E, F) Syntype of *N. vexillosa* (ZMB Q4069): (E) dorsal view; (F) ventral view. (G, H) Syntype of *N. vexillosa* (ZMB Q4068): (G) dorsal view; (H) ventral view. Arrows indicate lateral groups of paragnaths on area III. Scale bars, 2 mm.

Table 38. Mean pairwise genetic distances (K2P distance) based on COI sequences between *Nereis* sp. nov. 4 and *N. vexillosa* Grube, 1851. n = individuals.

Species	*N.* sp. nov. 4	*N. vexillosa*
N. sp. nov. 4 (n=1)	-	0.205
N. vexillosa (n=2)	0.205	0.000

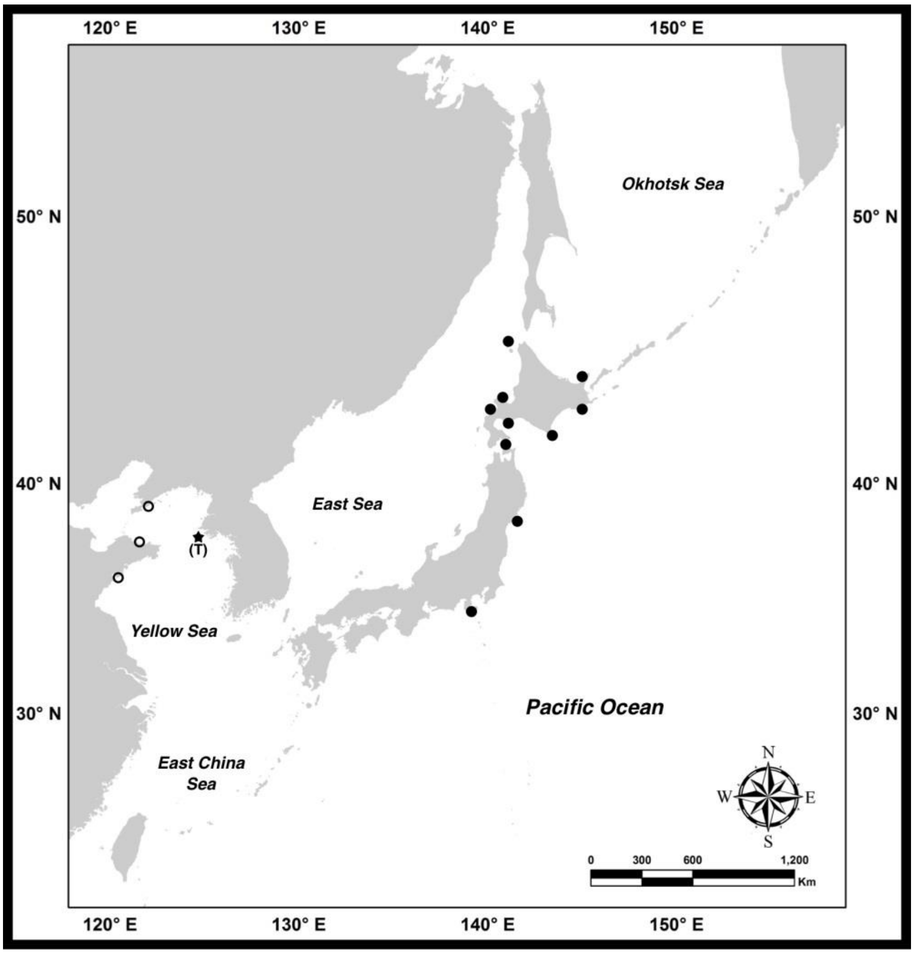

Fig. 70. Distribution of *Nereis* sp. nov. 4 in Northeast Asia based on the present study (★) and the literature. (●) Imajima (1972), (○) Wu et al. (1985). (T) Type locality.

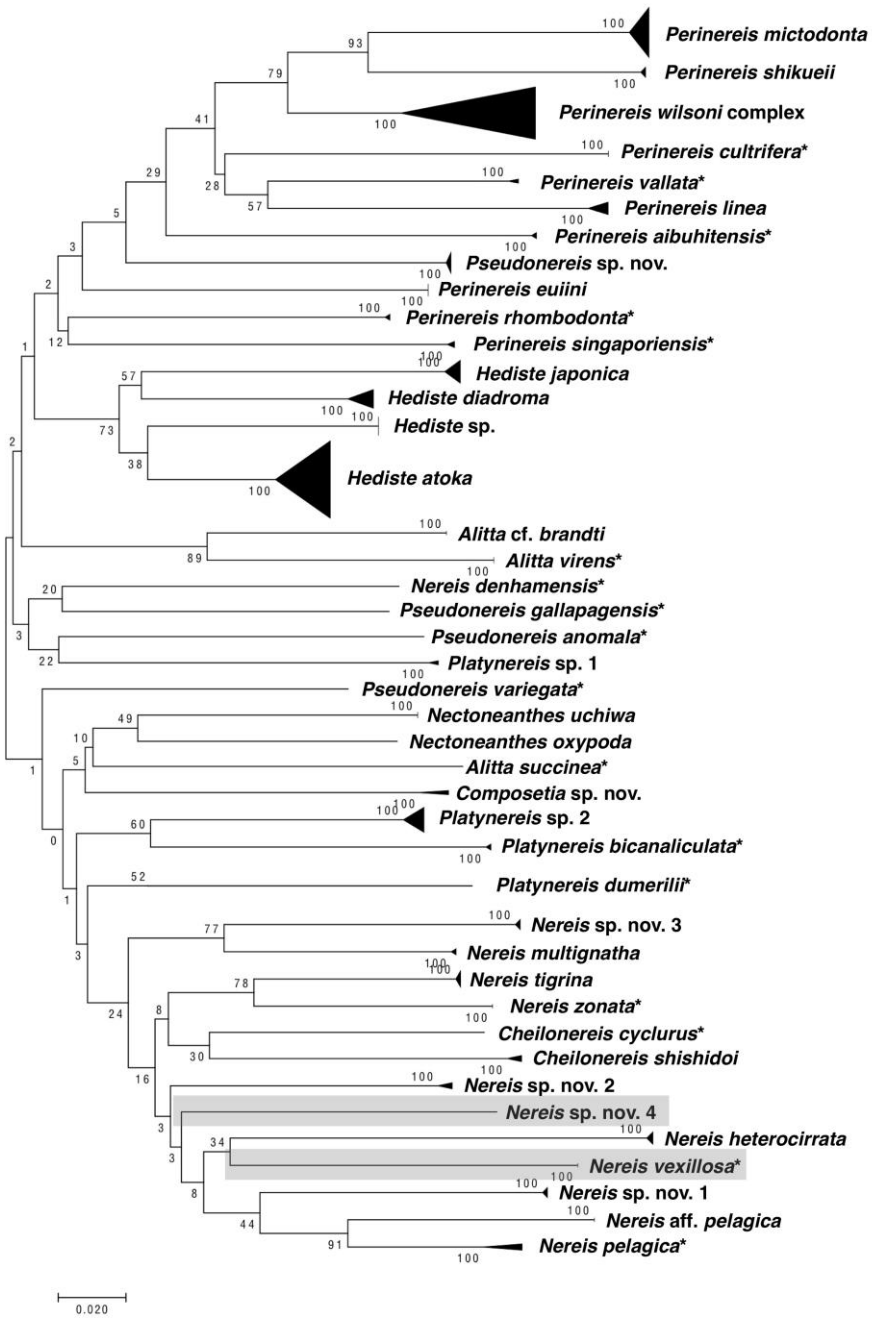

Fig. 71. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray box represents the difference between *Nereis* sp. nov. 4 and *N. vexillosa* Grube, 1851.

Table 39. Variation in paragnath number in area I to VIII on proboscis of *Nereis* sp. nov. 4. Ranges (mean ± standard deviation) are shown. L: left side, R: right side.

Locality	I	II(L)	II(R)	III	IV(L)	IV(R)	V	VI(L)	VI(R)
Korea (n=8) (Present study)	0–3 (0.75±1)	19–27 (22.5±3)	18–25 (21.4±2.4)	22–33 (28.1±3.9)	15–37 (31±7.6)	16–38 (30.6±7)	0	4–7 (5.4±1.1)	3–6 (4.8±1)
Japan (n=9) (Present stidy)	0–2 (0.89±0.6)	16–30 (22.6±4.8)	19–29 (24.7±3.8)	21–43 (32.2±8.2)	33–43 (38±3.6)	28–43 (35.9±4.5)	0	5–9 (6.6±1.6)	5–8 (6.4±1)
Korea (n=?) (Paik, 1977 as *N. vexillosa*)	1	about 20		about 30	about 40		0	7	
Japan (n=?) (Imajima, 1972 as *N. vexillosa*)	1	18–19		32	37–41		0	7	
China (n=?) (Wu et al., 1985 as *N. vexillosa*)	1–2	14–18		32–35	37–45		0	4–6	

Table 40. Comparison of paragnath numbers of *Nereis* sp. nov. 4 and *N. vexillosa* Grube, 1851.

Species (Locality and reference)	Range of paragnath number						
	I	II*	III (total)	III* (lateral)	IV*	V	VI*
N. sp. nov. 4 (Korea, present study, 8 type and non-types)	0–3	18–27	22–33	present	15–38	0	3–7
N. vexillosa (Okhotsk, present study, 2 syntypes, ZMBQ4070)	3	36–43	65–77	absent	46–63	0	6–7
(Alaska, present study, 1 syntype, ZMB Q4069)	2	50–55	83	absent	47–49	0	7
(Alaska or San Francisco, 1 syntype, ZMB Q4068)	3	34–42	71	absent	41–45	0	6

*Paragnath numbers on each side.

17. *Nereis tigrina* Zachs, 1933 (Figs. 72–75)

Nereis zonata var. *tigrina* Zachs, 1933: 128.

Nereis tigrina: Annenkova, 1938: 158–159, fig. 8; Uschakov, 1955: 213.

Materials examined

Non-type materials

NIBRIV0000540729, 1 ind.; NIBRIV0000540730, 1 ind., 5 m in depth, associated with sessile organisms in subtidal rocky area, Jodo islet, Gisamun-ri, Hyunbuk-myeon, Yangyang-gun, Gangwon-do, Korea, 22 July 2015, collected by Sang-Hwi Lee by SCUBA diving, fixed in 80% ethanol. NIBRIV0000545848, 3 inds.; NIBRIV0000783820, 1 ind.; NIBRIV0000783821, 1 ind., 8 m in depth, associated with sessile organisms in subtidal rocky area, White rock point in aqua gallery dive resort, Namae-ri, Hyeonnam-myeon, Yangyang-gun, Gangwon-do, Korea (37°56′8″N, 128°47′39″E), 11 June 2013, collected by Ye Eun, Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783823, 1 ind., 4 m in depth, associated with sessile organisms in subtidal rocky area, Oasis point in Aqua gallery dive resort, Namae-ri, Hyeonnam-myeon, Yangyang-gun, Gangwon-do, Korea (37°56′29″N, 128°47′15″E), 10 June 2013, collected by Ye Eun, Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783846, 1 ind., 8 m in depth, associated with sessile organisms in subtidal rocky area, Oasis point in Aqua gallery dive resort, Namae-ri, Hyeonnam-myeon, Yangyang-gun, Gangwon-do, Korea (37°56′29″N, 128°47′15″E), 3 July 2014, collected by Jong Moon Choi, Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783845, 1 ind., 27 m in depth, associated with sessile organisms in subtidal rocky area, Jungfrau point in Aqua gallery dive resort, Namae-ri, Hyeonnam-myeon, Yangyang-gun, Gangwon-do, Korea, 3 July 2014, collected by Jong Moon Choi, Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783822, 1 ind., 28 m in depth, associated with sessile organisms in subtidal artificial reef, Oasis point in Aqua gallery dive resort, Namae-ri, Hyeonnam-myeon, Yangyang-gun, Gangwon-do, Korea

(37°56′29″N, 128°47′15″E), 2 July 2014, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783824, 2 inds.; NIBRIV0000783825, 1 ind., 5 m in depth, associated with algal roots in subtidal rocky area, Beach point in LF Munam dive resort, Munanjin-ri, Jukwang-myeon, Goseong-gun, Gangwon-do, Korea (38°17′47″N, 128°33′E), 22 March 2017, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783241, 3 inds., 25 m in depth, associated with sessile organisms in artificial reef area, DBQ point in Aqua gallery dive resort, Namae-ri, Hyeonnam-myeon, Yangyang-gun, Gangwon-do, Korea, 25 June 2015, collected by Taeseo Park by SCUBA diving, fixed in 10% formalin. NIBRIV0000783247, 1 ind., 15 m in depth, associated with sessile organisms in subtidal rocky area, Novice point in Aqua gallery dive resort, Namae-ri, Hyeonnam-myeon, Yangyang-gun, Gangwon-do, Korea, 17 July 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783249, 3 inds., 25 m in depth, associated with sessile organisms in artificial reef area, DBQ point in Aqua gallery dive resort, Namae-ri, Hyeonnam-myeon, Yangyang-gun, Gangwon-do, Korea, 25 June 2015, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783699, 1 ind., 12 m in depth, associated with sessile organisms in subtidal rocky area, Garden hill point in Aqua gallery dive resort, Namae-ri, Hyeonnam-myeon, Yangyang-gun, Gangwon-do, Korea (37°56′32″N, 128°46′57″E), 12 June 2013, collected by Taeseo Park by SCUBA diving, fixed in 80% ethanol. NIBRIV0000783700, 1 ind., 18 m in depth, associated with sessile organisms in artificial reef area, Chuam dive resort point, Chuam-dong, Donghae-si, Gangwon-do, Korea, 14 July 2009, collected by Taeseo Park and Kyung-Jin Lee by SCUBA diving, fixed in 80% ethanol.

Diagnosis

Brown pigmentation (=-= shaped) present on dorsum in live specimens. Paragnath absent in area V, lateral group of paragnaths absent in area III. 4–6 irregular rows of minute paragnath present in area VII–VIII. Notopodial dorsal ligules gradually reduced posteriorly.

Noropodial prechaetal lobe absent.

Description of atokes

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum with stout pigmentation (=–= shaped) of brown color in live individuals (Figs. 74A, 75A), with pale pigmentation of brownish cream color in preserved ones.

Prostomium pyriform, slightly wider than long, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with palpophores and shorter thick-rounded palpostyles. Two pairs of eyes arranged trapezoidally; anterior pair slightly larger than posterior pair; gap of anterior pair slightly wider than posterior pair (Figs. 74A, 75A).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 4–6 (Fig. 74A).

Proboscis with pair of dark brown amber jaws, each with 5–6 teeth of serrated inner margin. Paragnaths present on both maxillary and oral rings except area V. Paragnath numbers and arrangements as follows: area I, 0–2 conical paragnaths; area II, 8–15 conical paragnaths on each side, arranged in two to three irregular rows; area III, 12–27 conical paragnaths in transverse band without lateral groups; area IV with conical and p-bar paragnath, 17–31 on left include 0–4 p-bars toward jaw, 11–37 on right include 0–5 p-bars toward jaw, arranged in curved cluster; area V, none; area VI, 2–10 conical paragnaths on left, 4–15 conical paragnaths on right; areas VII–VIII, single row of larger conical paragnaths on maxillary side, four to five rows of minute conical paragnaths on oral side (Figs. 74A–C, 75A–C; Table 42).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus.

In anterior parapodia (Fig. 74E), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule, twice longer than notopodial ventral ligules. Notopodial dorsal ligules oval with bluntly tapering tips, subequal to ventral ones; notopodial prechaetal lobes absent; notopodial ventral ligules oval with bluntly tapering tips, notoacicular papillae inconspicuous. Neuroacicular ligules subconical, postchaetal lobes absent; neuropodial ventral ligules globose, subequal to (or shorter than) neuroacicular ones. Ventral cirri shorter than neuropodial ligules, not extending beyond their tips.

In middle parapodia (Fig. 74F), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule, twice longer than notopodial ventral ligules. Notopodial dorsal and ventral ligules subequal, subconical, notoacicular papillae absent. Neuroacicular ligules globose, wider than long, slightly shorter than notopodial ventral ones, postchaetal lobes absent; neuropodial ventral ligules digitate with tapering tips, twice longer than neuroacicular ones. Ventral cirri one-third as long as neuropodial ventral ligules, not extending beyond their tips.

In posterior parapodia (Fig. 74G), dorsal cirri medially inserted, extending beyond notopodial dorsal ligule, one and half times longer than notopodial ventral ligules. Notopodial dorsal ligules subconical, slightly enlarged, longer than wide; notopodial ventral ligules subconical, longer than wide, slightly shorter than notopodial dorsal one, notoacicular papilla absent. Neuroacicular ligules oval, wider than long, half as long as notopodial ventral ones, postchaetal lobes absent; neuropodial ventral ligules subconical, as long as neuroacicular ligules. Ventral cirri shorter than neuropodial ventral ligules, not extending beyond their tips.

Notochaetae all homogomph spinigers in anterior parapodia, homogomph spinigers and falcigers in middle parapodia, all homogomph falcigers in posterior parapodia. Upper neurochaetae consisting of homogomph spinigers and heterogomph falcigers throughout. Lower neurochaetae consisting of heterogomph spinigers and heterogomph falcigers throughout (Fig. 74H–L). Chaetae decreased in number toward posterior end.

Notopodial homogomph spinigers with short serrated blades (Fig. 74K). Notopodial homogomph falcigers stout with rod-shaped blade with 3–4 teeth (Fig. 74H). Neuropodial homogomph and heterogomph spinigers (Fig. 74L) with long serrated blades. Neuropodial heterogomph falcigers stout with serrated blades, distally incurved (both medium and short types present) (Fig. 74I, J).

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers in each individual are summarized in Table 42.

Habitats

Subtidal zones (up to 3 m deep). Associated with sessile organisms such as algae, mussels, and oysters.

Distribution

Type locality: Peter the Great Bay, Russian Far East. East Asia (Korea, Japan, Russia) (Fig. 72).

Molecular data

The COI sequences obtained from eight individuals (Table 4, Appendix 2).

Remarks

Nereis tigrina is easily distinguished from its congeners by having distinct pigmentation patterns (=-= shaped) on the dorsum (Figs. 74A, 75A). Zachs (1933) reported this species for the first time from Peter the Great Bay, Russian Far East as one variety of *N. zonata* Malmgren, 1867. Later, Annenkova (1938) referred this as *N. tigrina*, a species distinct from *N. zonata*. Comparison of DNA sequences of COI between *N.*

tigrina and *N. zonata* revealed that they were markedly different from each other (mean p-distance: 0.132) (Table 42, Fig. 73). Therefore, it can be concluded that *N. tigrina* is a species distinct from previous stem species of *N. zonata*. This is the first record of this species from Korean waters.

Table 41. Mean pairwise genetic distances (K2P distance) based on COI sequences between *Nereis tigrina* Zachs, 1933 and *N. zonata* Malmgren, 1867. n = individuals.

Species	*N. tigrina*	*N. zonata*
N. tigrina (n=8)	0.001	0.132
N. zonata (n=2)	0.132	0.000

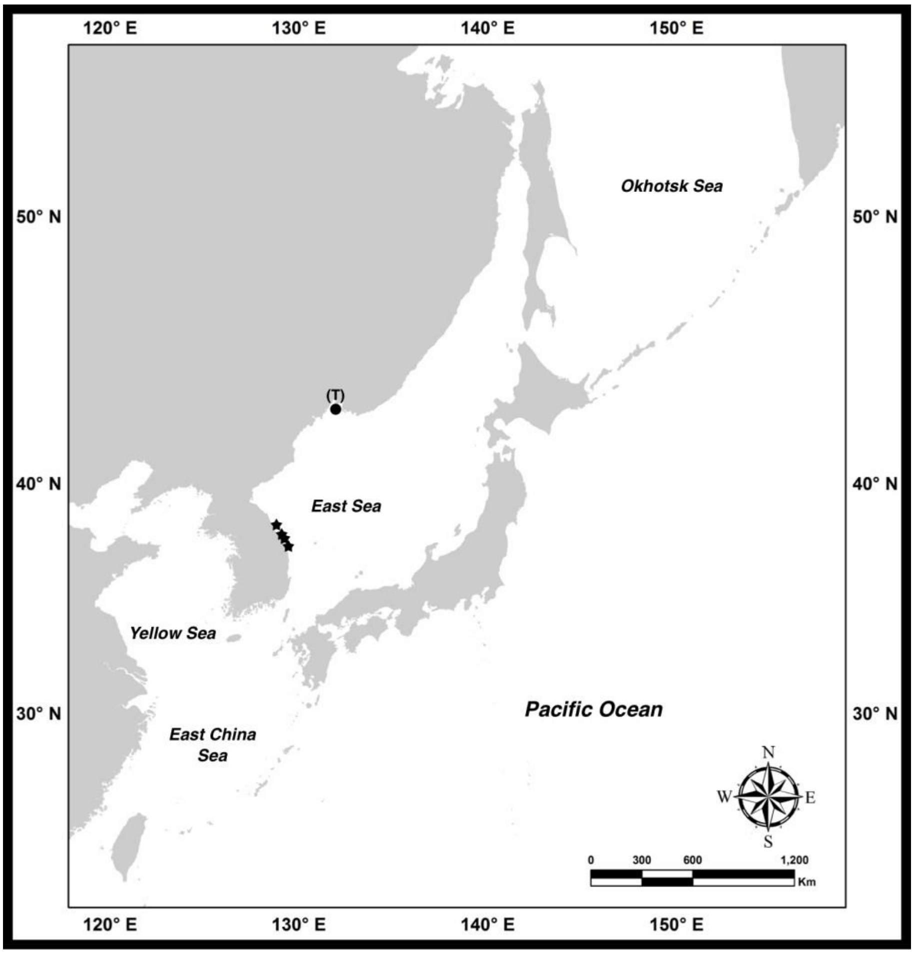

Fig. 72. Distribution of *Nereis tigrina* Zachs, 1933 in Northeast Asia based on the present study (★) and the literature. (●) Zachs (1933). (T) Type locality.

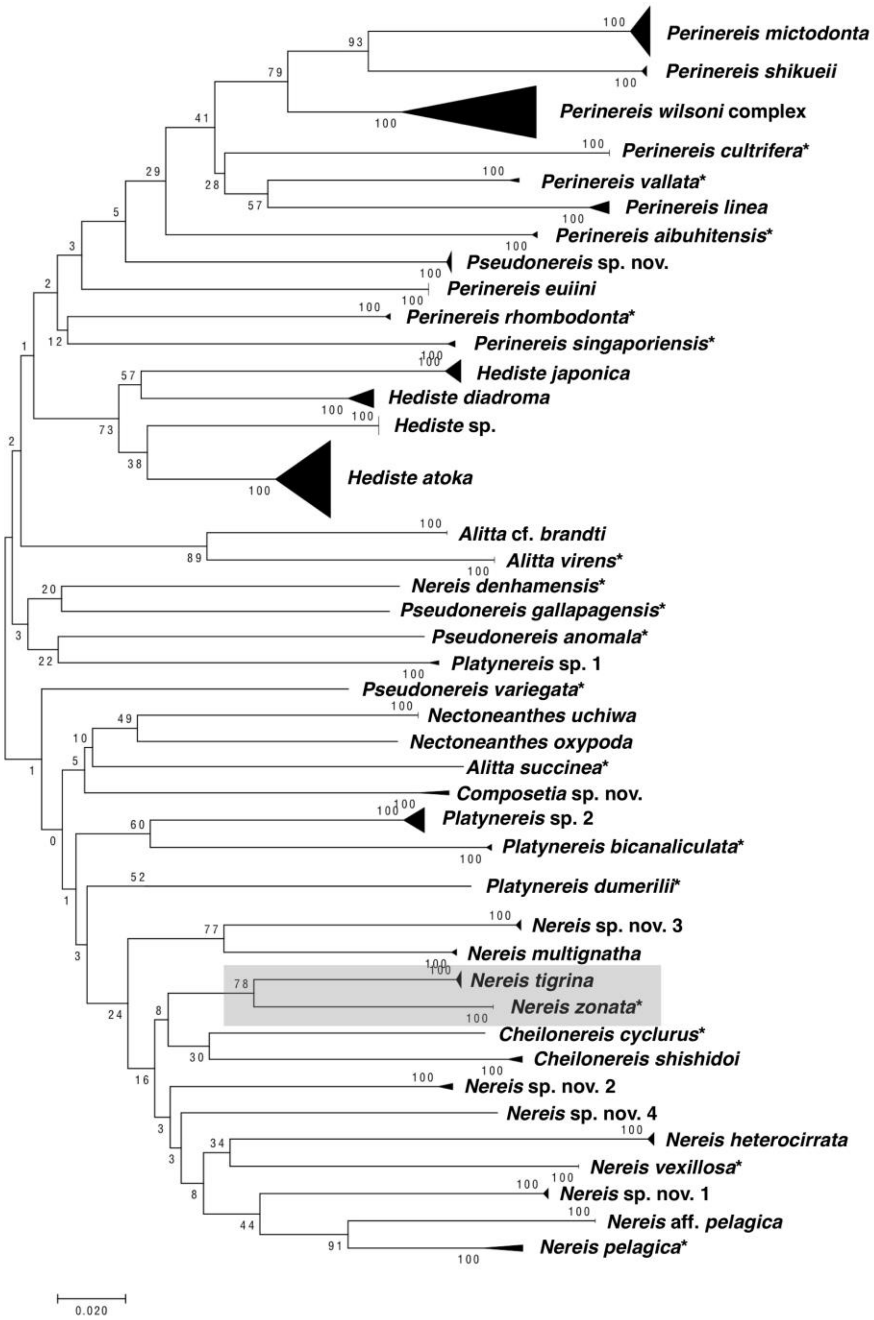

Fig. 73. Neighbor joining analysis (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray box represents the difference between *Nereis tigrina* Zachs, 1933 and *N. zonata* Malmgren, 1867.

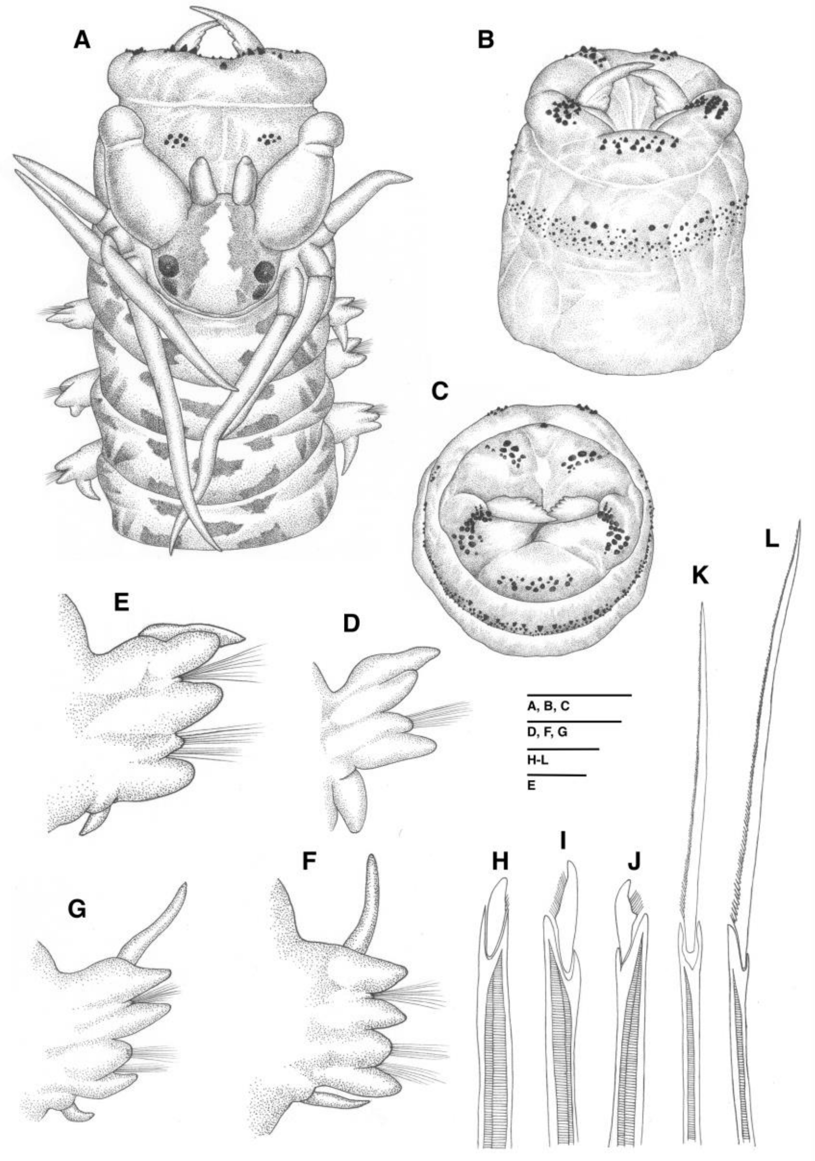

Fig. 74. *Nereis tigrina* Zachs, 1933, (A–G) NIBRIV0000540730; (H–L) NIBRIV0000540729. (A–C) Dorsal, ventral, and distal views of anterior end with the everted proboscis. (D–G) Anterior views of parapodium 1 (D); 7 (E, anterior); 29 (F, middle); 63 (G, posterior). (H) Homogomph falciger from notochaetae in parapodium 63. (I) Heterogomph falciger from upper neurochaetae in parapodium 7. (J) Heterogomph falciger from lower neurochaetae in parapodium 29. (K) Homogomph spiniger from notochaetae in parapodium 7. (L) Heterogomph spiniger from lower neurochaetae in parapodium 63. Scale bars: 0.5 mm in (A, B, C, E); 0.3 mm in (D, F, G); 0.03 mm in (H–L).

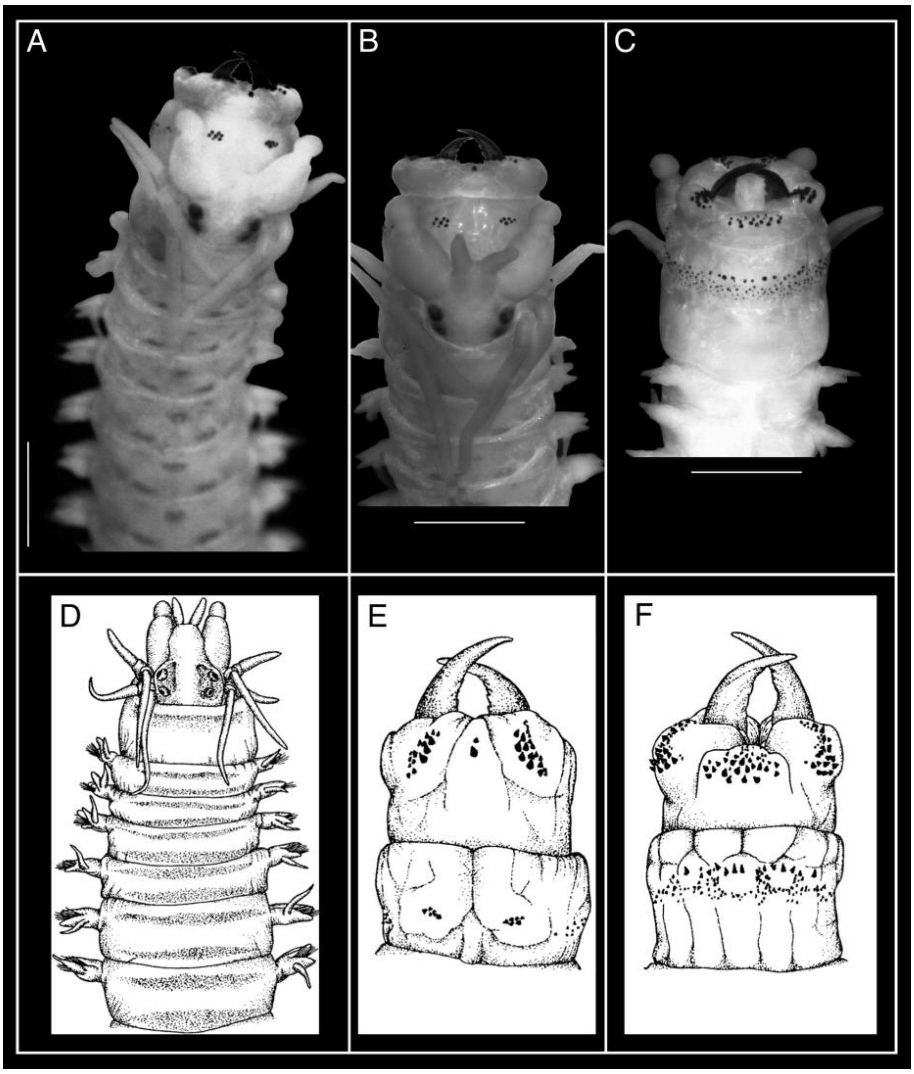

Fig. 75. Dorsal and ventral views of everted proboscis of *Nereis tigrina* Zachs, 1933 and *N. zonata* Malmgren, 1867. (A–C) *N. tigrina* (NIBRIV0000540730). (D–F) *N. zonata* (modified from Imajima, 1972). Scale bars, 2 mm.

Table 42. Variation in paragnath number in area I to VIII on proboscis of *Nereis tigrina* Zachs, 1933. Ranges (mean ± standard deviation) are shown. L: left side, R: right side.

Locality	I	II(L)	II(R)	III	IV(L)	IV(R)	VI(L)	VI(R)	VII–VIII
Korea (n=22) (Present study)	0–2 (1.1±0.5)	9–15 (12±2.1)	8–15 (12±2)	12–27 (18.1±4.4)	17–31 (25±3.8)	11–37 (24.6±5.5)	2–10 (6.6±1.9)	4–15 (7±2.7)	One row of regular paragnaths on maxillary side and 4–6 irregular rows of minute paragnaths (more than 200 in total)

Genus *Perinereis* Kinberg, 1865

Perinereis Kinberg, 1865: 175.

Type species: *Nereis novaehollandiae* Kinberg, 1865 (designated by Hartman 1948)

Diagnosis

Prostomium with entire anterior margin, one pair of antennae, one pair of biarticulated palps with palpostyles, four pairs of tentacular cirri with distinct cirrophores. Two pairs of eyes. One apodous anterior segment, greater than length of chaetiger 1. Maxillary ring of pharynx, conical paragnaths: area I, present or absent; II, present or absent; III, present; IV, present or absent, smooth bar-like paragnaths present or absent. Oral ring, conical paragnaths: area V, present or absent; VI, present or absent, smooth bars present; VII−VIII, present. Dorsal notopodial ligule similar in size in anterior and posterior chaetigers, or greatly expanded on posterior chaetigers. Notopodial prechaetal lobe present or absent, smaller than dorsal notopodial ligule on anterior chaetigers, usually reduced or absent posteriorly. Dorsal cirrus basally or mid-dorsally to subterminally attached to dorsal notopodial ligule on posterior chaetigers, lacking basal cirrophore. Neuropodial postchaetal lobe absent or present. Notoaciculae absent in chaetigers 1 and 2. Notochaetae: homogomph spinigers. Neurochaetae, dorsal fascicle: homogomph spinigers and heterogomph falcigers present. Neurochaetae, ventral fascicle: heterogomph spinigers present or absent, heterogomph falcigers present (modified from Bakken and Wilson, 2005).

18. *Perinereis euiini* Park and Kim, 2017 (Figs. 76–82).

Perinereis euiini Park and Kim, 2017: 252–260, figs. 1, 2, 3A, 4A, B, 5A, B.

Nereis cultrifera: Izuka, 1912: 151–153, pl. 16, figs. 7–14.

Perinereis cultrifera: Fauvel, 1936: 62–63; Okuda, 1938: 92; Okuda, 1950: 52, figs. i–j; Okuda and Yamada, 1954: 185, fig. 3F; Imajima and Hartman, 1964: 152;

Uschakov and Wu, 1965: 200–201 (trans. 1979: 64); Wu, 1967: 66–67; Imajima, 1972: 88–91, figs. 24a–l, 27; Imajima, 1996: 128–129, figs. 102, 102′; Paik, 1977: 174–176, fig. 17a–g; Paik, 1979: 41, 53, 58, fig. 7e, f; Paik, 1989: 314–315, pl. 27, figs. 64 (1–4), 74a–c; Wu et al., 1985: 213; Khlebovich, 1996: 145–146, fig. XLV1–7; Imajima 2003: 176; Sun and Yang, 2004: 186–190, figs. 106a–j, 107a–e.

Perinereis cultrifera var. *typica*: Khlebovich and Wu, 1962: 39; Khlebovich, 1963: 57; Uschakov and Wu, 1965: 200–201 (trans. 1979: 64).

Perinereis cultrifera typica: Wu et al., 1985: 214, fig. 118a–j (not fig. 121a–j).

Perinereis cultrifera var. *floridana*: Khlebovich and Wu, 1962: 39, 51; Khlebovich, 1963: 57; Uschakov and Wu, 1965: 200–201 (trans. 1979: 64); Imajima, 1972: 91, fig. 25a–b.

Perinereis cultrifera floridana: Rho and Lee, 1982: 39, pl. 3, figs. 2–3; Wu et al., 1985: 218, fig. 123a–b; Paik, 1989: 316, pl. 27, figs. 65 (1–2), 75; Imajima, 1996: 130, fig. 103; Khlebovich, 1996: 146; Sun and Yang, 2004: 186–190, fig. 108a–b.

Materials examined

Type materials

Holotype, NIBRIV0000502083, associated with algal roots in intertidal rocky shore, Gusan-myeon, Masan-si, Gyeongsangnam-do, Korea (35°6′41″N, 128°36′4″E), 28 June 2006, collected by Taeseo Park, fixed in 7% formalin. Paratypes: (1) NIBRIV0000502100, 1 ind., associated with mussels in intertidal boulder shore, Gagye Beach, Jindo-gun, Jeollanam-do, Korea, 8 October 2008, collected by Taeseo Park, fixed in 80% ethanol. (2) NIBRIV0000502101, 2 inds., associated with oysters in intertidal rocky shore, Dolsan-eup, Yeosu-si, Jeollanam-do, Korea (34°35′56″N, 127°47′45″E), 10 October 2008, collected by Taeseo Park, fixed in 80% ethanol. (3) NIBRIV0000502102, 1 ind., associated with algal roots in intertidal rocky shore, Gunnae-ri, Wando-eup, Wando-gun, Jeollanam-do, Korea (34°18′6″N, 126°46′12″E), 4 September 2013, collected by Taeseo Park, fixed in 80%

ethanol. (4) NIBRIV0000502103, 3 inds., 13 m in depth, associated with sessile organisms in subtidal rocky area near Baesimpo Port, Dongdo-ri, Samsan-myeon, Yeosu-si, Jeollanam-do, Korea (34°3′32″N, 127°19′34″E), 23 April 2013, collected by Taeseo Park, fixed in 80% ethanol. (5) NIBRIV0000771297, 1 ind., 15 m in depth, associated with sessile organisms subtidal artificial reef near Yulim Beach, Samsan-myeon, Yeosu-si, Jeollanam-do, Korea, 30 April 2013, collected by Taeseo Park, fixed in 80% ethanol. (6) NSMT-Pol P-621, 1 ind., 3 m in depth, associated with mussels in subtidal rocky area, Iyeopo Port, Seodo-ri, Samsan-myeon, Yeosu-si, Jeollanam-do, Korea (34°3′48″N, 127°16′91″E), 24 April 2013, collected by Taeseo Park, fixed in 80% ethanol.

Non-type materials

NIBRIV0000502104, 5 inds., associated with algal roots in intertidal rocky shore, Happo village, Wonpo-dong, Jinhae-gu, Changwon-si, Gyeongsangnam-do, Korea (35°5′48″N, 128°41′56″E), 29 June 2006, collected by Taeseo Park, fixed in 7% formalin. NIBRIV0000502105, 5 inds., associated with oysters, in intertidal rocky shore, Oklim-ri, Ilun-myeon, Geoje-si, Gyeongsangnam-do, Korea (34°51′5″N, 128°43′11″E), 20 March 2012, collected by Taeseo Park, fixed in 80% ethanol.

Comparative materials

Syntypes of *Nereis cultrifera* Grube, 1840 (ZMB 5653), Mediterranean Sea, Naples, Italy, 2 of 19 inds. Non-types of *Perinereis anderssoni* Kinberg, 1866 (USNM 24255), among masses of oysters, Sao Francisco, South Atlantic Ocean, Brazil, 7 October 1925, 6 of many inds., collected by W. L. Schmitt. Non-types of *Perinereis helleri* (Grube, 1878) (NIBRIV0000502065), St. Johns Island, Southern shore of Singapore, 26 November 2003, 5 inds., collector unknown. Non-types of *Perinereis cultrifera* var. *floridana* (Ehlers, 1868) (NSMT-Pol. 18672–18675), Mukaishima, Hiroshima Prefecture, Japan (34°21.7′N, 133°13.2′E), May 1964, 1 of 4 inds., collected by Minoru Imajima.

Diagnosis

Greenish brown pigmentation present on dorsum in live specimens. Single shield-shaped paragnath on each of area VI; three conical paragnaths arranged usually in triangle in area V; lateral group of paragnaths absent in area III. Notopodial dorsal ligules gradually and greatly expanded posteriorly. Small notopodial prechaetal lobe present in anterior and middle parapodia. Neuropodial postchaetal lobe absent.

Description of atokes

Holotype, complete with 90 chaetigers, 102 mm long, 3.5 mm and 5.3 mm wide excluding and including parapodia at chaetiger 10, respectively.

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum with stout pigmentation of greenish brown color in live individuals (Fig. 76), with pale pigmentation of brownish cream color in preserved ones.

Prostomium pyriform, slightly wider than long, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with palpophores and shorter round palpostyles. Two pairs of eyes arranged trapezoidally; anterior pair slightly larger than posterior pair; gap of anterior pair slightly wider than posterior pair (Fig. 77A).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 5 in holotype (4–8 in other materials examined) (Fig. 77A).

Proboscis with pair of dark brown amber jaws, each with 5–6 teeth of serrated inner margin (Fig. 77A, B). Conical paragnaths present on both maxillary and oral rings except area VI; single, shield-shaped paragnath on each side of area VI; paragnaths on oral ring slightly larger than those on maxillary ring. Paragnath numbers and arrangements in holotype as follows (range in other material given in parentheses): area I, 2 (1–3) in longitudinal arrangement; area II, 11 on right and 12 on left (8–16), arranged in oblique triangular patch; area III, 14 (10–15) in oval patch without lateral groups; area IV, 22 on right and 21 on left (16–26), without bar-shaped paragnath, arranged in about three oblique rows; area V, 3 (3–3) in triangular arrangement; area VI, single shield-shaped paragnath on each side; areas VII–VIII, 33 (33–40) in two irregular rows in central area (area VII) and single row in lateral sides (area VIII) (Figs. 77A, B; 79A, B).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with reduced notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus (Fig. 77C).

Notopodia consisting of dorsal cirrus, dorsal ligule, small prechaetal lobe, and ventral ligule in biramous parapodia (Figs. 77D–G; 80A, B). Dorsal cirri slender, slightly shorter than (or same in length as) notopodial dorsal ligule in anterior and middle parapodia, same in length as notopodial ventral ligule in posterior parapodia (Fig. 77H, I). Notopodial dorsal ligule oval with bluntly tapering tip in anterior parapodia (Fig. 77D, E), gradually expanding in middle parapodia and greatly expanding up to three times length of notopodial ventral ligule in posterior parapodia (Fig. 77H, I). Notopodial prechaetal lobe shorter than notopodial dorsal and ventral ligules, gradually reducing posteriorly (Fig. 77D, F, H). Notopodial ventral ligule oval with bluntly tapering tip throughout.

Neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus throughout. Superior and inferior lobes present in neuropodial acicular lobe in anterior and middle parapodia (Fig. 77D–G), gradually reduced posteriorly (Fig. 77H, I). Neuropodial ventral ligule oval with bluntly tapering tip throughout. Ventral cirri slender, shorter than ventral ligules throughout.

Notochaetae all homogomph spinigers; blades long with finely serrated edge (Fig. 77J). Upper neurochaetae consisting of heterogomph falcigers with serrated blades at anterior position, and homogomph spinigers with long serrated blades at posterior position (Fig.

78A). Lower neurochaetae consisting of heterogomph falcigers with serrated blades (Fig. 77L) at both anterior and posterior positions, and heterogomph spinigers with long serrated blades (Fig. 77K) at superior posterior position (Fig. 78A).

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri (Fig. 1).

Variation in paragnath number

Paragnath numbers in *Perinereis euiini* Park and Kim, 2017 from four countries are summarized in Table 44.

Habitats

Intertidal and subtidal zones (up to 10 m deep). Under stones in mudflats or rocky shores or associated with sessile organisms such as algae, mussels, and oysters.

Distribution

Type locality: Masan-si, Gyeongsangnam-do, Korea. East Asia (China, Taiwan, Korea, Japan) (Fig. 81).

Molecular data

The COI sequence data obtained from six individuals (Table 4, Appendix 2).

Etymology

The species is named in honor of the late Prof. Eui-In Paik who pioneered taxonomic studies on Korean polychaetes.

Remarks

Perinereis euiini is similar to *P. cultrifera* (Grube, 1840). However, it clearly differs from *P. cultrifera* in the following two diagnostic characteristics: (1) the absence of lateral groups of paragnaths on area III (Figs. 77B; 79A, B; Table 45), in contrast to the presence of those in *P. cultrifera* (Fig. 79C, Table 45), and (2) notopodial dorsal ligules greatly expanded (up to three times longer than notopodial ventral ligule) in posterior parapodia (Figs. 77H; 80A-2, B; Table 45), in contrast to those not so greatly expanded (up to twice longer than notopodial ventral ligule) in *P. cultrifera* (Fig. 80F, Table 45).

Morphological characteristics of all specimens previously reported as *P. cultrifera* from East Asian waters, i.e., China, Taiwan, Korea, and Japan (Izuka, 1912; Fauvel, 1936; Okuda, 1938, 1950; Okuda and Yamada, 1954; Khlebovich and Wu, 1962; Khlebovich, 1963, 1996; Imajima and Hartman, 1964; Uschakov and Wu, 1965; Wu, 1967; Imajima, 1972, 1996, 2003; Paik, 1977, 1979, 1989; Rho and Lee, 1982; Wu et al., 1985; Sun and Yang, 2004) agreed well with those of *P. euiini* (Table 44). Therefore, it is concluded that they all belong to *P. euiini* and that *P. cultrifera* is not a cosmopolitan species.

This conclusion is supported by results of DNA sequence comparison of COI between *P. euiini* and "*P. cultrifera*" from China and Portugal. DNA sequences of specimens from Portugal markedly differed from *P. euiini* (mean p-distance: 0.226). However, those from China were identical to those of *P. euiini* (Table 43, Fig. 82), indicating that Portugal specimens belonged to *P. cultrifera sensu stricto*, whereas Chinese specimens belonged to *P. euiini*, not *P. cultrifera*.

Perinereis euiini is also similar to *P. floridana* (Ehlers, 1868). However, it differs from *P. floridana* in the following two diagnostic characteristics: (1) the presence of notopodial prechaetal lobes (Fig. 80A-1), in contrast to the absence of notopodial prechaetal lobes in *P. floridana* (Fig. 80E-1, Table 45), and (2) notopodial dorsal ligules greatly expanded in posterior parapodia, in contrast to those not expanded in *P. floridana* (Fig. 80E-2, Table 45) (de Leon-Gonzalez and Solis-Weiss, 1998; de Leon-Gonzalez and Goethel, 2013).

Fauvel (1932) has relegated *P. floridana* to one variety of *P. cultrifera* based on materials collected from India and adjacent areas. In East Asia (i.e., China, Korea, and Japan), Khlebovich and Wu (1962), Khlebovich (1963, 1996), Uschakov and Wu (1965), Imajima (1972, 1996), Rho and Lee (1982), Wu et al. (1985), Paik (1989), and Sun and Yang (2004) have recorded *P. cultrifera* var. *floridana* (or *P. cultrifera floridana*) which is different from the Asian "*P. cultrifera*" in paragnath number on area V (one instead of three). In the present study, we confirmed that the general morphology of Asian specimens reported as *P. cultrifera* var. *floridana* (or *P. cultrifera floridana*) well agreed with that of *P. euiini* (Fig. 79B, Table 44). Therefore, we judged that they did not belong to *P. floridana sensu stricto*, but to *P. euiini*, considering that their aberrant paragnath number in area V was an intraspecific variation of *P. euiini*.

Wu et al. (1985) have reported six ecological subspecies of *P. cultrifera*. Among them, *P. cultrifera typica* and *P. cultrifera floridana* are synonymized as *P. euiini* in the present study. On the other hand, all four varieties of *P. cultrifera* erected by Fauvel (1932) based on Indian specimens do not belong to *P. euiini* because the diagnostic characteristic of *P. euiini* does not agree with Fauvel's (1932: p. 105) following description: "In all these forms, the posterior feet are not materially modified. The dorsal ligule, in fact, protrudes over the ventral division, but is not enlarged into a large flag-like process bearing the dorsal cirrus near its tip, ...". In addition, not-greatly expanded notopodial dorsal ligule in posterior parapodia is shown in Fauvel's (1953: p. 207) figure (fig. 106c).

Perinereis euiini is similar to *P. anderssoni* Kinberg, 1866 (type locality: Rio de Janeiro, Brazil) and *P. helleri* (Grube, 1878) (type locality: Bohol Island, Philippines). However, it is different from them in the following two diagnostic characteristics: (1) the absence of lateral groups of paragnaths on area III, in contrast to the presence of those in *P. anderssoni* (Fig. 79D) and *P. helleri* (Fig. 79E), and (2) the presence of notopodial prechaetal lobes, in contrast to the absence of those in *P. anderssoni* (Fig. 80D, Table 45) and *P. helleri* (Fig. 80C, Table 45).

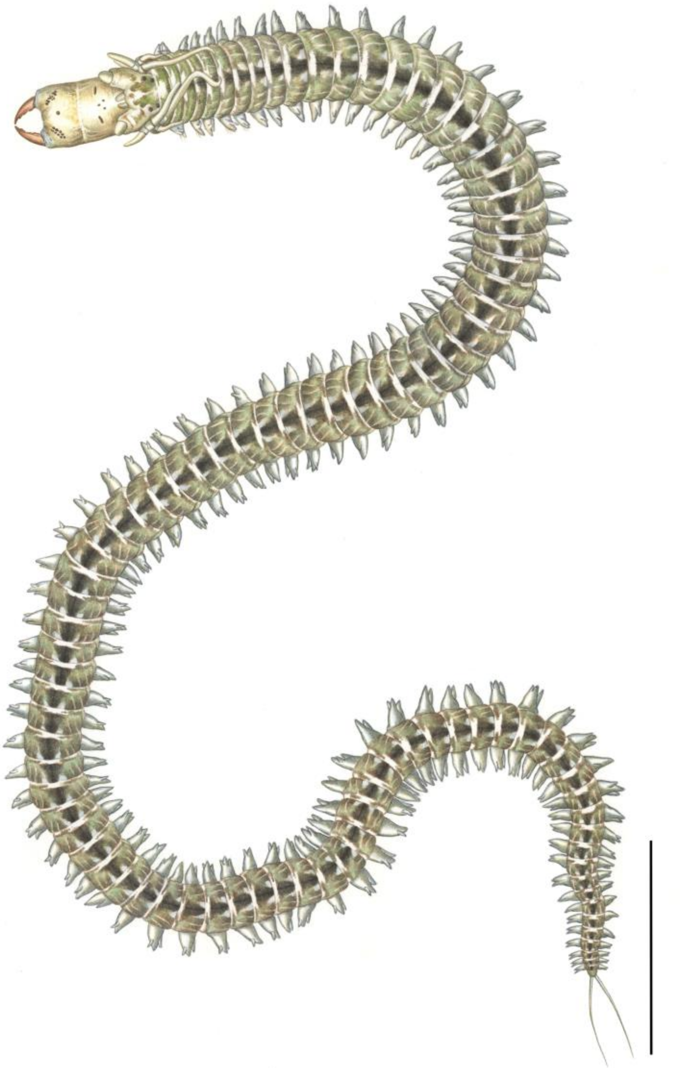

Fig. 76. Drawing of *Perinereis euiini* Park and Kim, 2017 based on a paratype (NIBRIV0000502103). Scale bar, 10 mm.

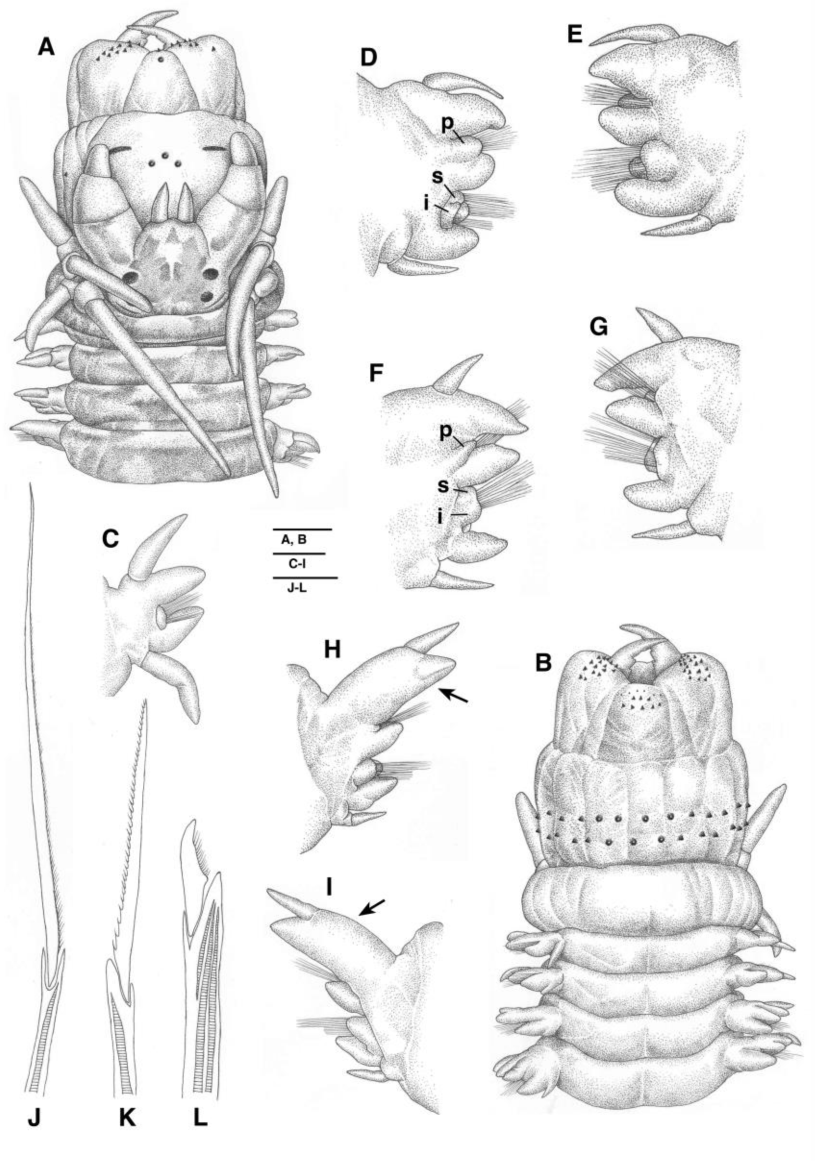

Fig. 77. *Perinereis euiini* Park and Kim, 2017, holotype, NIBRIV0000502083. (A, B) Dorsal and ventral views of anterior end with the everted proboscis. (C) Anterior view of parapodium 1. (D–I) Anterior and posterior views of parapodium 9 (D, E); 46 (F, G); 79 (H, I). (J) Homogomph spiniger from notochaetae in parapodium 46. (K) Heterogomph spiniger from lower neurochaetae in parapodium 9. (L) Heterogomph falciger from lower neurochaetae in parapodium 9. i, inferior lobe; p, prechaetal lobe; s, superior lobe. Arrows indicate greatly expanded notopodial dorsal ligule. Scale bars: 1 mm in (A, B); 0.5 mm in (C–I); 0.03 mm in (J–L).

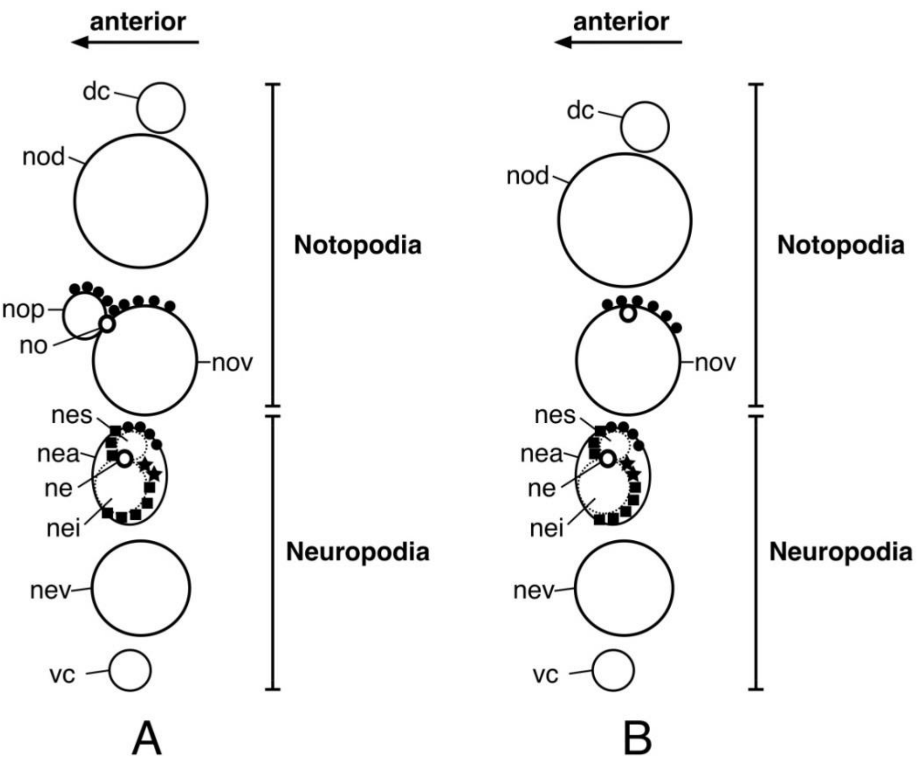

Fig. 78. Schematic diagrams of atokous chaetal arrangement in distal view of anterior left parapodium. (A) *Perinereis euiini* and *P. cultrifera*. (B) *P. anderssoni*, *P. floridana*, and *P. helleri*. (●): homogomph spiniger. (★): heterogomph spiniger. (■): heterogomph falciger. dc, dorsal cirrus; nod, notopodial dorsal ligule; nop, notopodial prechaetal lobe; no, notoacicula; nov, notopodial ventral ligule; nes, neuropodial superior lobe; nea, neuropodial acicular lobe; ne, neuroacicula; nei, neuropodial inferior lobe; nev, neuropodial ventral ligule; vc, ventral cirrus.

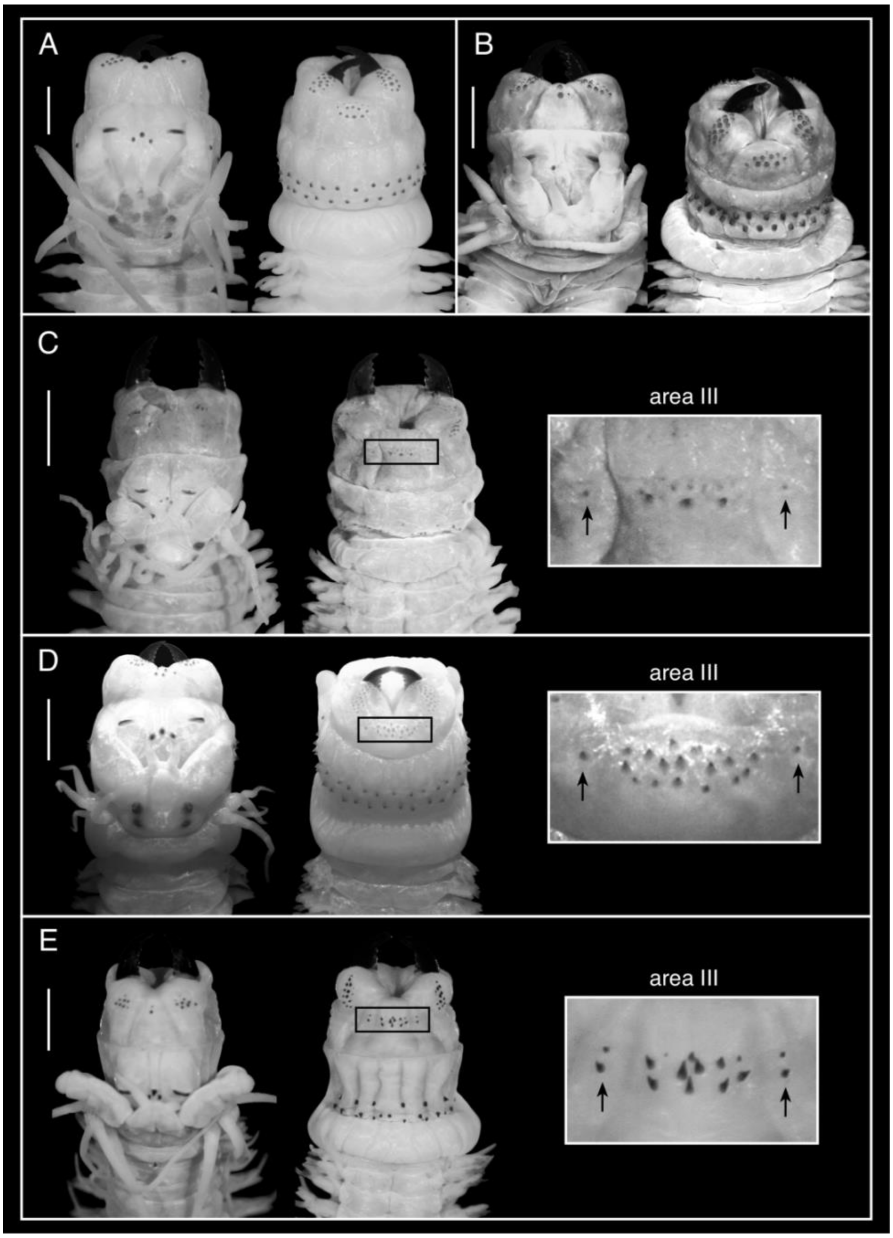

Fig. 79. Dorsal (left) and ventral (right) views of everted proboscis of four *Perinereis* species. (A, B) *P. euiini*: (A) holotype; (B) a Japanese specimen previously identified as *P. cultrifera* var. *floridana* (NSMT-Pol. 18672–18675). (C) *P. cultrifera* (one of syntypes, ZMB 5653). (D) *P. anderssoni* (USNM 24255). (E) *P. helleri* (NIBRIV0000502065). Images of the enlargement of area III on the proboscis are added in (C–E). Arrows indicate lateral groups of paragnaths on area III. Scale bars: 1 mm.

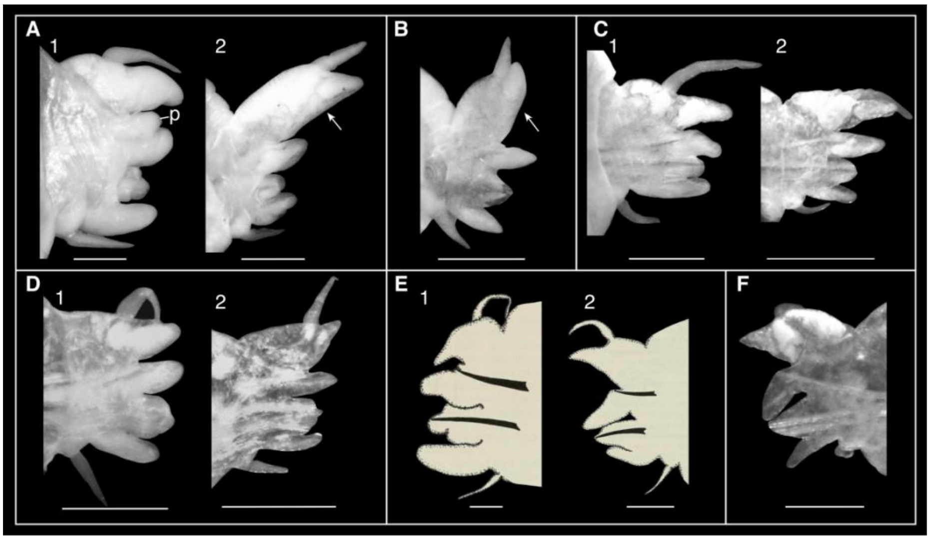

Fig. 80. Anterior view of parapodia of *Perinereis euiini* Park and Kim, 2017. (A, B) and four other closely related species (C–F). Images of chaetae are removed. (A, B) *Perinereis euiini*: (A) holotype, anterior (1) and posterior (2) parapodia; (B) a Japanese specimen previously identified as *P. cultrifera* var. *floridana* (NSMT-Pol. 18672–18675), posterior parapodium. p, prechaetal lobe. Arrows indicate greatly expanded notopodial dorsal ligule. (C) *P. helleri* (NIBRIV0000502065), anterior (1) and posterior (2) parapodia. (D) *P. anderssoni* (USNM 24255), anterior (1) and posterior (2) parapodia. (E) *P. floridana* (modified from de Leon-Gonzalez and Solis-Weiss, 1998), anterior (1) and posterior (2) parapodia. (F) *P. cultrifera* (one of syntype, ZMB 5653), posterior parapodium. Scale bars: 0.5 mm in (A–D, F); 0.1 mm in (E).

Table 43. Mean pairwise genetic distances (K2P distance) based on COI sequences among *Perinereis euiini* Park and Kim, 2017, "*P. cultrifera* (Grube, 1840)" from China, and "*P. cultrifera*" from Portugal. n = individuals.

Species	*P. euiini*	"*P. cultrifera*" from China	"*P. cultrifera*" from Portugal
P. euiini (n=3)	0.000	0.000	0.226
"*P. cultrifera*" from China (n=3)	0.000	0.000	0.226
"*P. cultrifera*" from Portugal (n=3)	0.226	0.226	0.000

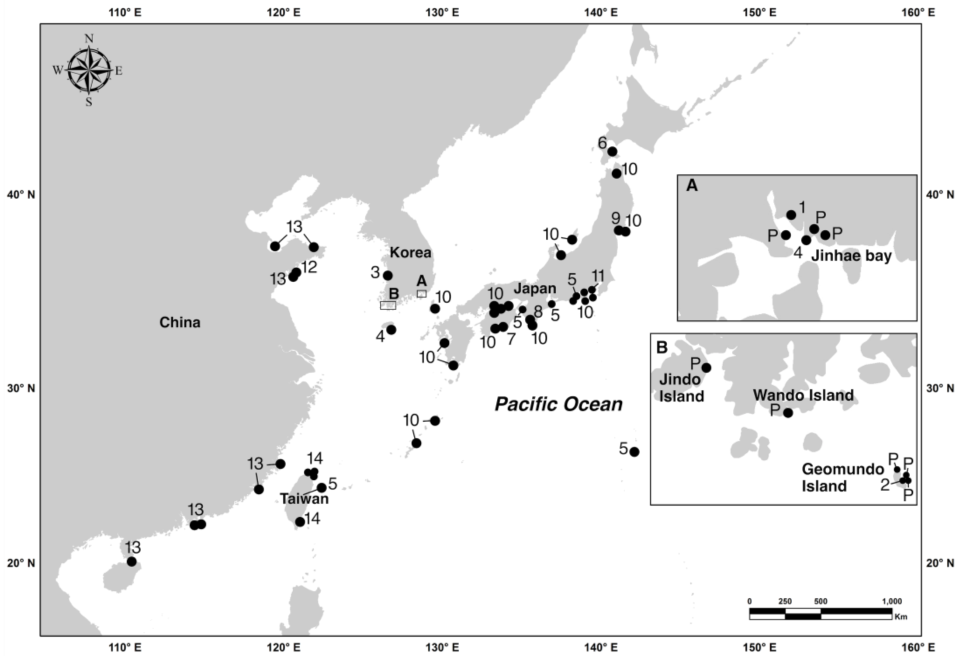

Fig. 81. Distribution of *Perinereis euiini* Park and Kim, 2017 in East Asia based on the present study (P) and the literature (1–14). 1: Paik (1977), 2: Paik (1979), 3: Rho and Lee (1982), 4: Paik (1989), 5: Izuka (1912), 6: Fauvel (1936), 7: Okuda (1938), 8: Okuda (1950), 9: Okuda and Yamada (1954), 10: Imajima (1972), 11: Imajima (2003), 12: Uschakov and Wu (1965), 13: Wu et al. (1985), 14: Wu (1967).

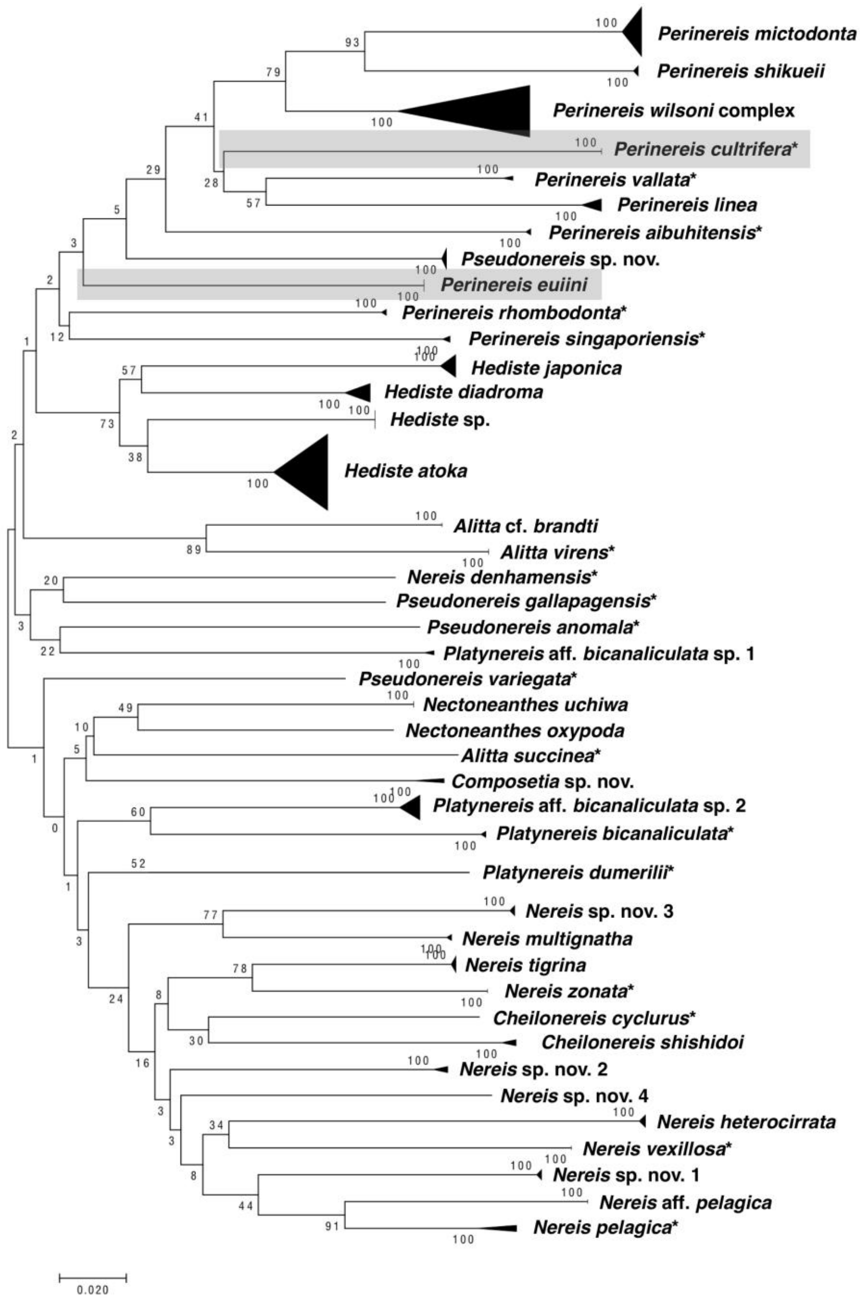

Fig. 82. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray box represents the difference between *Perinereis euiini* Park and Kim, 2017 and *P. cultrifera* (Grube, 1840).

Table 44. Variation in paragnath numbers in area I to VII–VIII on proboscis of *Perinereis euiini* Park and Kim, 2017. Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Locality (Reference)	**I**	**II***	**III**	**IV***	**V**	**VI***	**VII–VIII**
Korea (n=20) (Present study)	1–3 (2±0.4)	8–16 (12.1±2)	10–15 (13±1.6)	16–26 (21.4±2.4)	3	1	33–40 (36.6±2)
Korea (n=?) (Paik, 1977, 1989 as *P. floridana*)	2	13	15	20–22	3	2–3	two rows
Korea (n=?) (Rho and Lee, 1982; Paik, 1989 as *P. c. foridana*)	?	?	?	?	1	1	two rows
Japan (n=?) (Imajima, 1972, 1996 as *P. cultrifera*)	2	12–13	12–14	20–22	3	1	two rows
Japan (n=1) (Present study, as *P. c. floridana*)	2	15	10	20–23	1	1	34
China (n=?) (Wu et al., 1985, as *P. c. typica*)	1–2	10–26	10–15	20–30	3	1	two rows
China (n=?) (Wu et al., 1985, as *P. c. floridana*)	1–2	?	?	?	1	1	?
Taiwan (n=?) (Wu, 1967, as *P. cultrifera*)	2–3	15–16	15–16	22	3	1	38

*Paragnath numbers on each side.

Table 45. Comparison of key characteristics of *Perinereis euiini* Park and Kim. 2017 with four closely similar species.

Species (Locality and reference)	**Range of paragnath number**								**Notopodial prechaetal lobe**	**Posterior notopodial dorsal ligule**
	I	**II***	**III (total)**	**III* (lateral)**	**IV***	**V**	**VI***	**VII–VIII**		
P. euiini (Korea, present study, 20 type and non-types)	1–3	8–16	10–15	absent	16–26	3	1	33–40	present	expanded up to 3 times longer than notopodial ventral ligule
P. cultrifera (Naples, Hutchings et al., 1991, 19 syntypes)	1–2	3–15	5–11	present	6–20	2–5	1	20–50	present	expanded up to 2 times longer than notopodial ventral ligule
(Naples, present study, 2 syntypes)	1	4–7	10–12	1–2	10–16	3	1	32–36	present	expanded up to 2 times longer than notopodial ventral ligule
P. anderssoni (Brazil, present study, 6 non-types)	4–6	11–17	17–23	0–1	28–37	3	1	39–43	absent	expanded up to 2 times longer than notopodial ventral ligule
(Brazil, de León-González & Solís-Weiss, 1998)	4	13	19	1**	27	3	1	45	absent	enlarged
P. floridana (Mexico, de León-González & Solís-Weiss, 1998)	2	9	16	?	18	1	1	24	absent	nor enlarged
P. helleri (Philippines, Australia, Hutchings et al., 1991, Type and non-types)	2	4–17	11–20	2–3	10–19	3	1	21–40	absent	slightly enlarged
(Singapore, present study, 5 non-types)	2	6–10	12–17	2–3	12–17	3–4	1	25	absent	slightly enlarged

*Paragnath numbers on each side.

**Personal information from Jesús Angel de León-González.

19. *Perinereis linea* (Treadwell, 1936) (Figs. 83–86)

Nereis (*Neanthes*) *linea* Treadwell, 1936: 268–270, fig. 19a–e.

Nereis (*Neanthes*) *orientalis* Treadwell, 1936: 270–272, figs. 19f–i. **syn. nov.**

Neanthes virens (M. Sars, 1835): Paik, 1975: 412–413, pl. 3, figs. 16–24; 1977: 200–202, fig. 29A–F; 1982: 789, pl. 14j–i; 1989: 339–341, pls. 32, 33, fig 78(1–3), text fig. 89A, B.

Perinereis linea: Wu, 1967: 68–69, figs. 10a–d; Arias et al., 2013: 1–12, figs. 2–5; Sakaguchi, 2015: 63–71, figs. 16–18.

Perinereis vancaurica tetradentata Imajima, 1972: 86–88, fig. 23; Paik, 1975: 7, pl. 6, figs. 44–46; 1977: 172–174, figs. 16a–f; 1989: 309–311, figs. 72a–e. **syn. nov.**

Perinereis aibuhitensis: Wu et al., 1985: 189–193, figs. 107–109; Lee et al., 1992: 1–10, figs. 2–3; Sun and Yang, 2004: 180–183, figs. 101–103; Kim et al., 2014: 869–870.

Materials examined

Type materials

Holotype of *Nereis* (*Neanthes*) *linea* Treadwell, 1936 (USNM 20115), Fujian, Amoy, Xiamen, China, collected by T. Y. Chen. Holotype of *Nereis* (*Neanthes*) *orientalis* Treadwell 1936 (USNM 20116), Fujian, Amoy, Xiamen, China, collected by T. Y. Chen. Holotype of *Perinereis vancaurica tetradentata* Imajima, 1972 (NSMT-Pol-H78), Sumida River, Tokyo, Japan, 20 July 1908, collected by A. Izuka.

Non-type materials

NIBRIV0000783811, 1 ind., NIBRIV0000783812, 1 ind., NIBRIV0000783813, 1 ind., NIBRIV0000783814, 11 inds., muddy tidal flat, Ganghwado Is., Dongmak-ri, Hwado-myeon, Ganghwa-gun, Incheon-si, Korea, 12 May 2013, collected by Taeseo Park, fixed in 10% formalin. NIBRIV0000317216, 3 inds., NIBRIV0000317217, 2 inds., NIBRIV0000317218, 2 inds., NIBRIV0000317220, 2 inds., Daehang-ri, Byeonsan-myeon, Buan-gun, Jeollabuk-do, Korea (35°41′55.3″N, 126°33′8.4″E), 13 August 2014, collected by Hyun-Ki Choi. NIBRIV0000129004, 4 inds., Sangam-ri, Buan-myeon, Gochang-gun, Jeollabuk-do, Korea, 24 July 2007, collected by Ye Eun and Sun-Sang Hong. NIBRIV0000262307, 1 ind., Songnim-ri, Janghang-eup, Seocheon-gun, Chungcheongnam-do, Korea, 9 August 2010, collected by Sa-Heung Kim. NIBRIV0000521098, 1 ind., Dongho-ri, Haeri-myeon, Gochang-gun, Jeollabuk-do, Korea (35°31′18″N, 126°29′8.84″E), 3 May 2015, collected by Hyun-Ki Choi. NIBRIV0000282343, 1 ind., Jungsan-dong, Jung-gu, Incheon-si, Korea (37°31′45.19″N, 126°35′25.83″E), 7 March 2012, collected by Soon-Young Wang. 7 inds., Dalian, China, no further data, collected by Sun Ruiping.

Comparative materials

Paralectotype of *Nereis* (*Perinereis*) *aibuhitensis* Grube, 1878 (ZMB Q3440), 1 ind., Aibuhit, Palau, no further data. Topotypes of *Perinereis aibuhitensis* (Grube, 1878) (NIBRIV0000787926), 4 inds., mangrove, Melekeok, Palau (7°28′5″N, 134°36′42″E), 5 August 2013, collected by Taeseo Park and Ye Eun, fixed 80% ethanol; Non-types, (NIBRIV0000787927), 23 inds., mangrove, Koh Kong, Cambodia, 6 September 2011, collected by Taeseo Park, fixed 70% ethanol; (NIBRIV0000787924), 1 ind., sandy beach, Koh Rung Samloem Is., Cambodia (10°37′20″N, 103°17′37″E), 29 April 2012, collected by Taeseo Park, fixed 80% ethanol.

Diagnosis

Dark green pigmentation present on dorsum in live specimens. Usually 2 short bar-shaped paragnath present on each of area VI; a transverse cluster paragnaths in a rectangular patch without lateral group area III; long curved and pointed paragnath present in a crescentic raws in area II. Notoacicular papilla present in anterior and middle parapodia, Notopodial prechaetal and neuropodial postchaetal lobes absent.

Description of atokes

Based on 30 specimens. Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum with pigmentation of dark green color in live individuals with pale pigmentation of cream color in preserved ones.

Prostomium pyriform, slightly wider than long, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with palpophores and shorter round palpostyles. Two pairs of eyes arranged trapezoidally; anterior pair slightly larger than posterior pair; gap of anterior pair wider than posterior pair. Longitudinal mid-dorsal groove present on dorsum of prostomium (Fig. 83A).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 4–8 in most specimens (Figs. 83B, 84D).

Proboscis with pair of dark brown amber jaws, each with 6–9 teeth of serrated inner margin (Fig. 83A, B). Conical paragnaths present on both maxillary and oral rings except area VI; usually 2 (1–3) short bar-shaped paragnath on each side of area VI; paragnaths on oral ring larger than those on maxillary ring. Paragnath numbers and arrangements as follows: area I, 2–8 in rhombus patch; area II, 10–25 on right and 8–25 on left with curved and pointed conical paragnath, arranged in 2 or 3 crescentic rows; area III, 32–70 in rectangular patch without lateral groups; area IV, 13–31 on right and 11–26 on left, without bar-shaped paragnath, arranged in about three oblique rows; area V, 2–5 in triangular arrangement; area VI, 1–3 short bar-shaped paragnath on each side; areas VII–VIII, 43–81 in two irregular rows in central area (area VII) and single row in lateral sides (area VIII) (Figs. 83A–C; 84D).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with reduced notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus (Fig. 83D).

Notopodia consisting of dorsal cirrus, dorsal ligule, notoacicular papilla, and ventral ligule in biramous parapodia (Figs. 83E–H). Dorsal cirri slender, slightly shorter than (or same in length as) notopodial dorsal ligule in anterior and posterior parapodia, half as long as notopodial dorsal ligule in middle parapodia (Fig. 83F). Notopodial dorsal ligule subtriangular with tapering tip in anterior parapodia (Fig. 83E), gradually reducing toward posteriorly (Fig. 83H). Large notoacicular papilla present from anterior parapodia especially large specimens, gradually reducing posteriorly (Fig. 83E–H). Notopodial ventral ligule subtrinagular with tapering tip, same in length as notopodial dorsal ligule throughout.

Neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus throughout. Superior and inferior lobes present in neuropodial acicular lobe in anterior and middle parapodia (Fig. 83E, F), gradually reduced posteriorly (Fig. 83G, H). Neuropodial ventral ligule oval with tapering tip throughout. Ventral cirri slender, half as long as ventral ligules throughout.

Notochaetae all homogomph spinigers; blades long with finely serrated edge (Fig. 83K). Upper neurochaetae consisting of long heterogomph falcigers with half serrated blades at anterior position, and homogomph spinigers with long serrated blades at posterior position. Lower neurochaetae consisting of long heterogomph falcigers with half serrated blades (Fig. 83I) at both anterior and posterior positions, and heterogomph spinigers with long serrated blades (Fig. 83J) at superior posterior position.

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers in *Perinereis linea* are summarized in Table 47.

Habitats

Intertidal mudflats.

Distribution

Type locality: Amoy (Xiamen), China. Eastern Asia (China, Taiwan, Korea, Japan) (Fig. 85).

Molecular data

The COI sequences obtained from six individuals (Table 4, Appendix 2).

Remarks

Treadwell (1936) reported *Nereis* (*Neanthes*) *linea* as a new species from Amoy, China. Hartman (1938) synonymized *N.* (*N.*) *linea* with *P. aibuhitensis* (Grube, 1878). In Japan, Imajima (1972) reported *P. vancaurica tetradentata* as a new subspecies. He referred that *P. linea* reported by Wu (1967) from Taiwan corresponded to the specimen from Japan, but not that by Treadwell (1936). Later, Lee et al. (1992) synonymized *P. v. tetradentata* with *P. aibuhitensis* based on the study of Wu et al. (1985). Consequently, all nominal species of *N.* (*N.*) *linea*, *P*. *linea sensu* Wu, 1967, and *P*. *v*. *tetradentata* from Northeast Asia have been synonymized with *P. aibuhitensis* by Hartman (1938) and Lee et al. (1992).

However, a recent study of Arias et al. (2013) and the present study confirmed that *P. linea* differs from *P. aibuhitensis* by the following characteristics: (1) the absence of lateral groups of paragnaths in area III (Fig. 84C, D), in contrast to the presence of lateral groups of paragnaths in *P. aibuhitensis* (Fig. 84E-2, F-2, Table 48), (2) curved conical paragnaths in area II arranged in crescentic rows (Fig. 84A-2, B-2, C-1, D-1), in contrast to short stout paragnaths arranged in triangular patch in *P. aibuhitensis* (Fig. 84E-1, F-1).

This conclusion is supported by results of DNA sequence comparison for COI between *P. linea* and *P. aibuhitensis* from Northeast Asia and Palau (type locality) respectively (Fig.

86). Mean pairwise distance between *P. linea* and *P. aibuitensis* was 0.274 (Table 46).

Arias et al. (2013) referred that *P. linea* appeared to be very similar to *P. v. tetradentata* based on literature descriptions of the latter. However, this needs to be confirmed by examining type material. In this study, it was confirmed that key morphological characteristics of *P. linea* and *P. v. tetradentata* were identical based on examination of both type specimens (Fig. 84A, C, Table 47).

Hartman (1938) synonymized *N.* (*N.*) *orientalis* Treadwell, 1936 with *P. aibuhitensis*. However, the present examination indicates that morphological characteristics of type specimens of *N.* (*N.*) *orientalis* and *N.* (*N.*) *linea* are identical to each other (Fig 84A, B, Table 47). These two nominal species were described as new species by Treadwell (1938) in the same publication. Because the type specimen of *N.* (*N.*) *orientalis* is in epitokous stage, *N.* (*N.*) *linea* should be given priority according to Article 24.2.1 of ICZN. Thus *N.* (*N.*) *orientalis* Treadwell, 1938 becomes a junior synonym of *P. linea*.

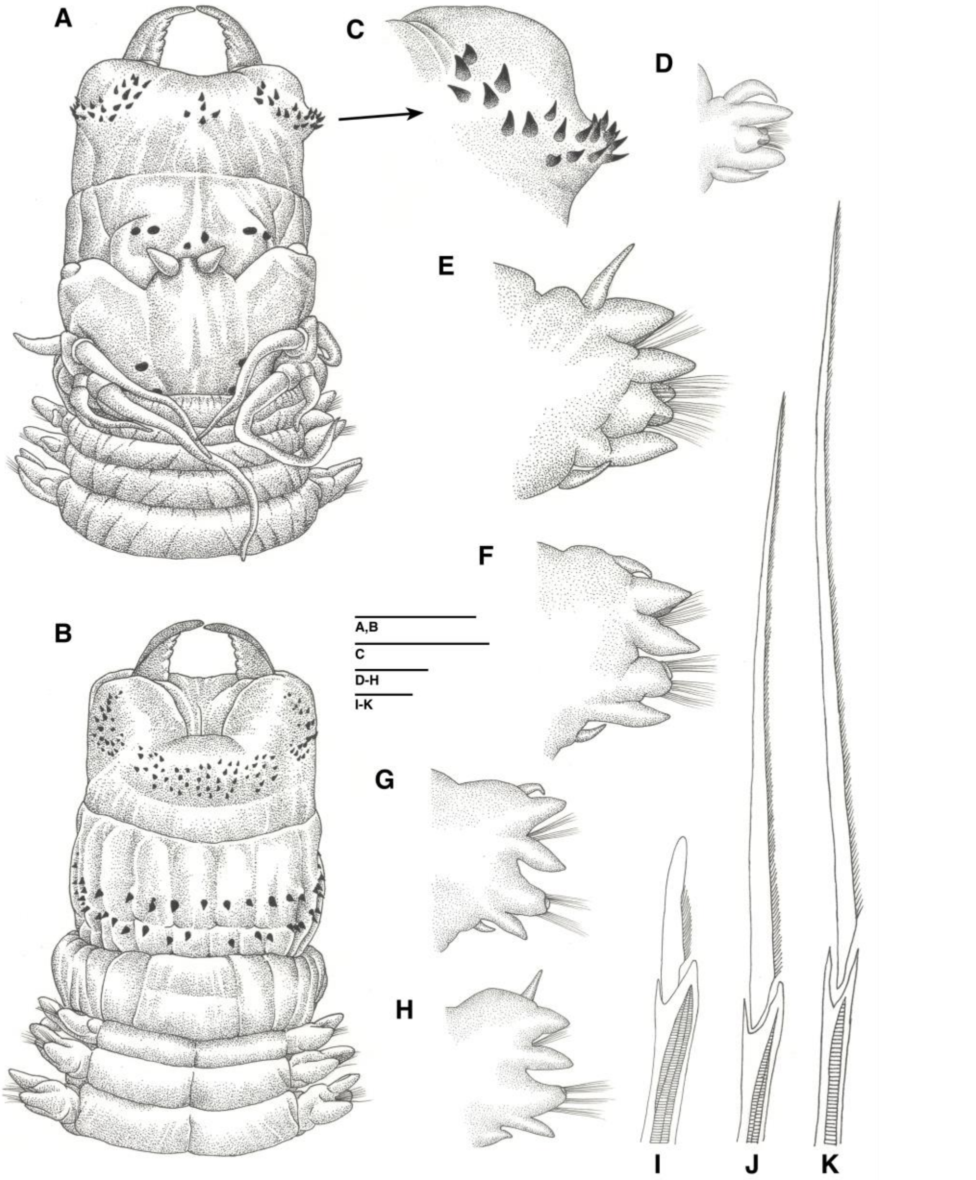

Fig. 83. *Perinereis linea* (Treadwell, 1936), (A–C) NIBRIV0000783811, (D–K) NIBRIV0000783812. (A, B) Dorsal and ventral views of anterior end with the everted proboscis. (C) Curved paragnaths on area II. (D–H) Anterior view of parapodium 1 (D); 10 (E); 34 (F); 70 (G); 125 (H). (I) Heterogomph spiniger from upper neurochaetae in parapodium 34. (J) Heterogomph spiniger from lower neurochaetae in parapodium 70. (K) Homogomph spiniger from notochaetae in parapodium 34. Scale bars: 2 mm in (A, B); 1 mm in (C–H); 0.02 mm in (I–K).

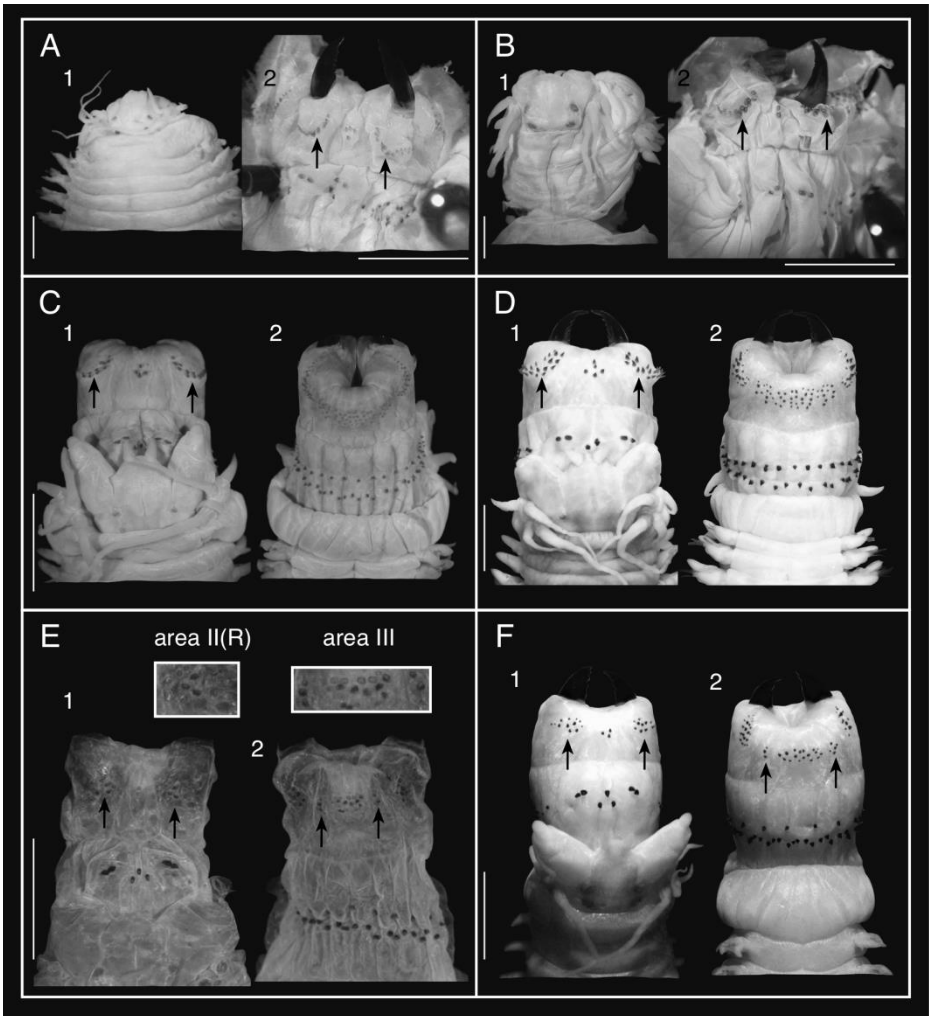

Fig. 84. Dorsal (left) and ventral (right) views of everted proboscis of *Perinereis linea* (Treadwell, 1936) and *P. aibuhitensis* (Grube, 1878). (A–D) *P. linea*: (A) holotype of *Nereis* (*Neanthes*) *linea* Treadwell, 1936 (USNM 20115), (1) dorsal view, and (2) ventral view; (B) holotype of *N.* (*N.*) *orientalis* Treadwell 1936 (USNM 20116), (1) dorsal view, and (2) ventral view; (C) holotype of *P. vancaurica tetradentata* Imajima, 1972 (NSMT-Pol-H78), (1) dorsal view, (2) and ventral view; (D) non-type of *P. linea* (NIBRIV0000783811), (1) dorsal view, (2) ventral view. Arrows indicate curved row of paragnaths on area II. (E, F) *P. aibuhitensis*: (E) paralectotype of *N.* (*Perinereis*) *aibuhitensis* Grube, 1878 (ZMB Q3440), (1) dorsal view, and (2) ventral view; (F) topotype of *P. aibuhitensis* (NIBRIV0000787926), (1) dorsal view and, (2) ventral view. Arrows indicate (1) triangular cluster of paragnaths on area II, and (2) lateral groups of paragnaths on area III. Scale bars: 2 mm.

Table 46. Mean pairwise genetic distances (K2P distance) based on COI sequences between *Perinereis linea* (Treadwell, 1936) and *P. aibuhitensis* (Grube, 1878). n = individuals.

Species	*P. linea*	*P. aibuhitensis*
P. linea (n=3)	0.009	0.274
P. aibuhitensis (n=6)	0.274	0.002

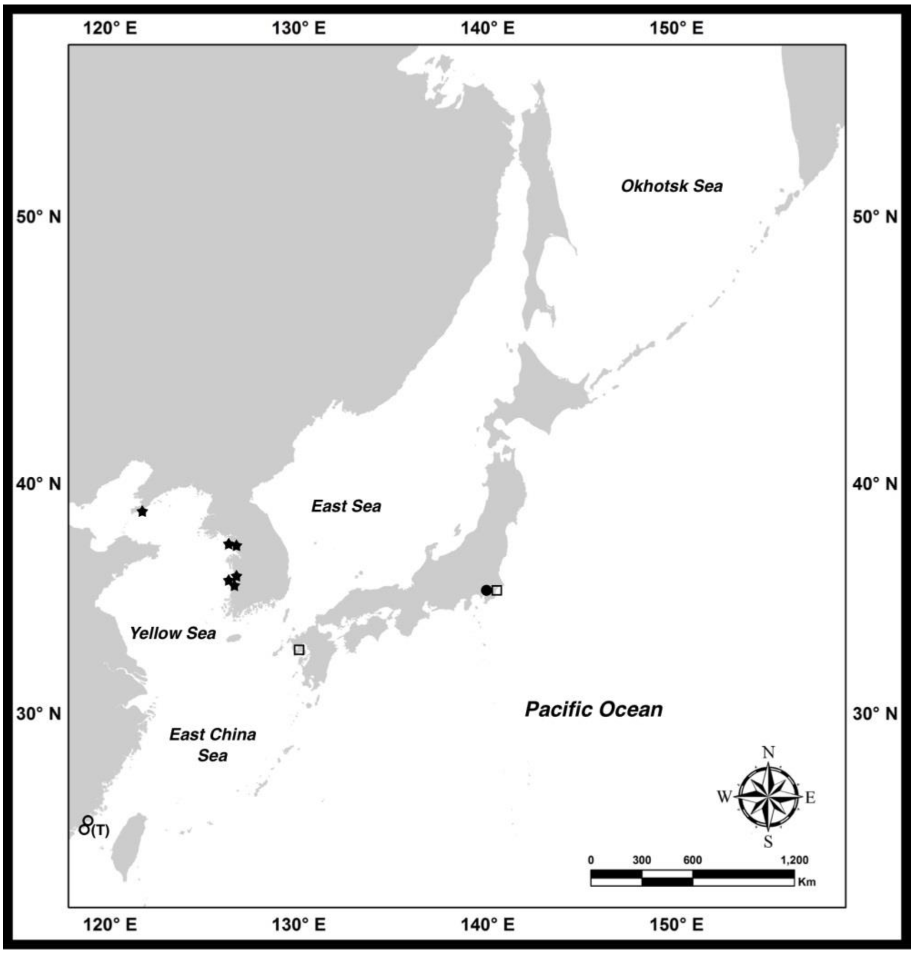

Fig. 85. Distribution of *Perinereis linea* (Treadwell, 1936) in Northeast Asia based on the present study (★) and the literature. (○) Treadwell (1936), (●) Imajima (1972), (□) Sakaguchi (2015, unpublished data). (T) Type locality.

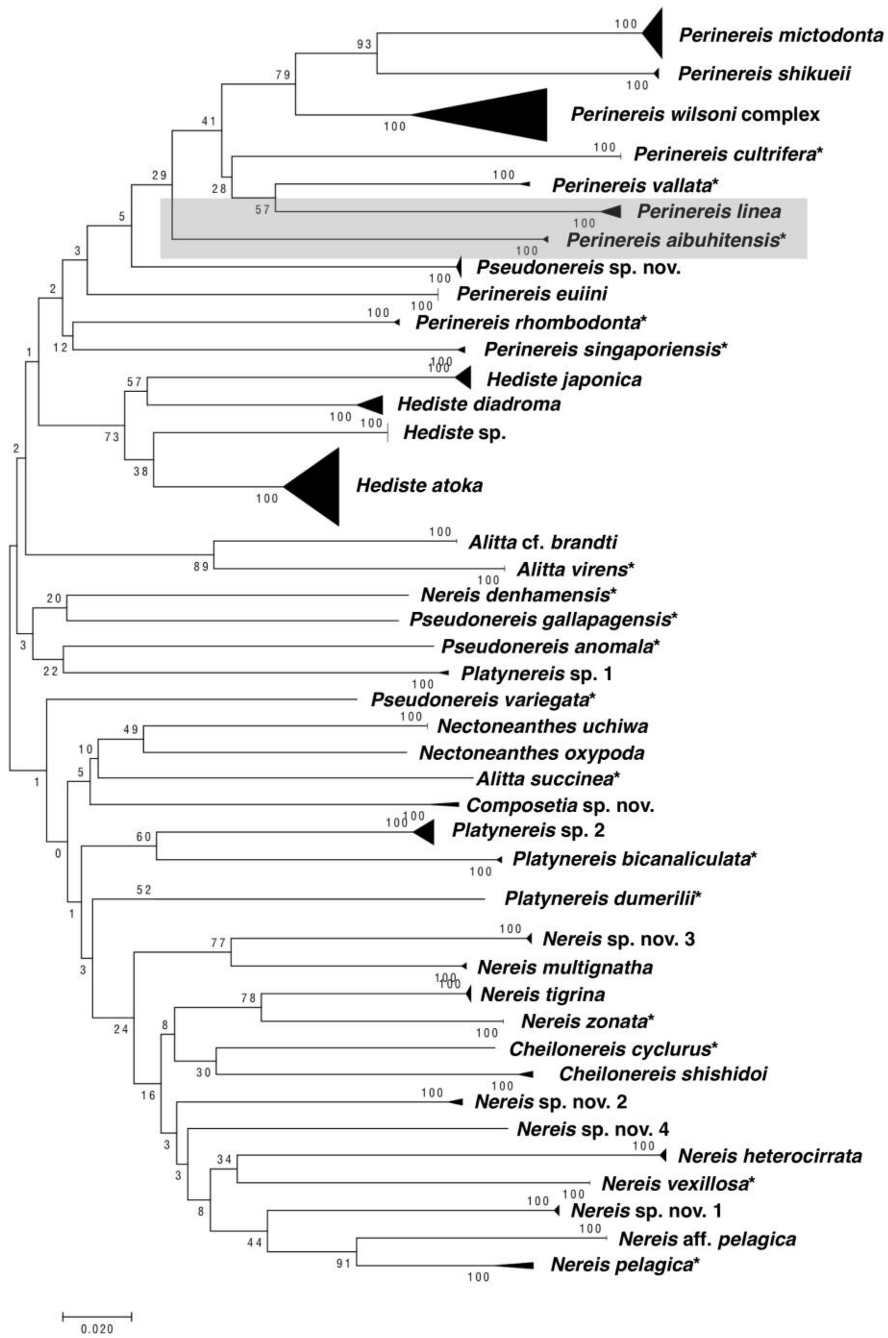

Fig. 86. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray box represents the difference between *Perinereis linea* (Treadwell, 1936) and *P. aibuhitensis* (Grube, 1878).

Table 47. Variation in paragnath numbers in area I to VIII on proboscis of *Perinereis linea* (Treadwell, 1936). Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Locality	I	II(L)	II(R)	III	IV(L)	IV(R)	V	VI(L)	VI(R)	VII–VIII
Korea (n=37) (Present study)	2–8 (4.4±1.2)	8–25 (18.6±3.3)	10–25 (18.5±3.6)	32–70 (47.5±8.2)	11–26 (19.8±3.3)	13–31 (20.4±4.1)	2–5 (3.1±0.5)	1–3 (2.2±0.4)	1–3 (2.1±0.4)	43–81 (58±7.6)
Korea (n=?) (Paik, 1977 as *P. vancaurica tetradentata*)	4	15–17		50	16–21		3	2–3		many in two rows
Korea (n=?) (Lee et al., 1992 as *P. aibuhitensis*)	3–4	12–20		40–45	13–20		2–3	2–4		many in two rows
Korea (n=?) (Paik, 1977 as *Neanthes virens*)	4–5	13–19		about 20	14–25		3–5	3–4		three irregular transverse rows
China, Dalian (n=7) (Present study)	3–5 (4±0.8)	16–23 (20.3±2.3)	17–25 (20.7±2.4)	39–60 (52.4±8.3)	19–25 (21.9±2)	18–24 (19.9±2)	3–4 (3.3±0.5)	2	2	52–70 (60.1±7.3)
China (Present study, holotype of *Nereis* (*Neanthes*) *linea*)	4	17	19	48	16	14	3	2	3	51
China (Present study, holotype of *Nereis* (*Neanthes*) *orientalis*)	2	17	20	46	19	17	3	2	2	41

Table 47. Continued.

Locality	I	II(L)	II(R)	III	IV(L)	IV(R)	V	VI(L)	VI(R)	VII–VIII
China (n=?) (Wu et al., 1985 as *P. aibuhitensis*)	2–6	12–29		30–50	18–25		2–4	2–4		many
Taiwan (n=1) (Wu, 1967 as *P. linea*)	4	about 14		about 60	24		3	2		60
Japan (Holotype, Imajima, 1972 as *P. vancaurica tetradentata*)	4	19–21		55	23–24		3	2		many
Mediterranean Sea (n=42) (Arias et al., 2013)	4–6	16–17		41–50	15–18		3–4	2–3		30–90

Table 48. Comparison of key characteristics of *Perinereis linea* (Treadwell, 1936) and *P. aibuhitensis* (Grube, 1878).

Species (Locality and reference)	**Range of paragnath number**							
	I	**II***	**III (total)**	**III* (lateral)**	**IV***	**V**	**VI***	**VII–VIII**
P. linea (Korea, present study, 37 non-types)	2–8	8–25	32–70	absent	11–31	2–5	1–3	43–81
P. aibuhitensis (Palau, Cambodia, present study, 27 topotypes and non-types)	2–9	7–16	14–31	present	5–26	2–5	2–4	22–47
(Palau, present study, 1 paralectotype)	2	7–10	22	present	8–9	3	2	31
(Palau, Australia, Hutchings et al, 1991)	1–4	6–14	12–34**	present (2–5)	8–23	3	2	37–48
(Darwin in Australia, 13 non-types, Arias et al., 2013)	2	8–12	13–15**	present (2–3)	17–24	3–4	2	40–51

*Paragnath numbers on each side.

**Paragnath number not include lateral group.

20. *Perinereis mictodonta* (Marenzeller, 1879) (Figs. 87A–D, 88, 93)

Nereis mictodonta Marenzeller, 1879: 118, pl. 2, fig. 2; Izuka, 1912: 148, pl. 16, figs. 1–6.

Perinereis nuntia var. *brevicirris*: Fauvel, 1936: 63; Okuda, 1938: 92; 1939: 231; 1940: 12; Okuda and Yamada, 1954: 184, fig. 3e; Khlebovich and Wu, 1962: 51, pl. 3, fig. 3; Imajima, 1972: 94, fig. 26l–m; Paik, 1972: 131, fig. 2i–j; Wu et al., 1985: 208, fig. 120a, b.

Perinereis brevicirris: Imajima and Hartman, 1964: 151; Wu, 1967: 71, fig. 11a–d (in part).

Perinereis nuntia: Paik, 1975: 242, fig. 1a–d (in part); 1989: 311, pl. 26, 27, figs. a, b(1, 2), c(1, 2), text fig. 73A–G (in part).

Perinereis mictodonta: Wilson and Glasby, 1993: 264; Glasby and Hsieh, 2006: 558, fig. 5A–E; Park and Kim, 2007: 76–80, figs. 2A–D, 3A, 4A, 5A–B, 6.

Perinereis sp. 1: Chen et al, 2002: 19.

Materials examined

Non-type materials

NIBRIV0000787941, 5 inds., Yeonpyungdo Is., Yeonpyung Harbor, Yeonpyung-myeon, Ongjin-gun, Incheon-si, Korea (37°39′7″N, 125°41′35″E), 12 February 2013, collected by Pyung-Gang Lee, fixed in 80% ethanol. NIBRIV0000787944, 1 ind., Yue, Ariake-cho, mouth of small river, Ariake Sea, Japan, 17 November 2007, collected by Masanori Sato. NIBRIV0000787943, 1 ind., Saigogawa River, Nagasaki Prefecture, Japan, 2 August 2012, collected by Masanori Sato. NIBRIV0000787942, 1 ind., Saigogawa River, Shimabara, Nagasaki Prefecture, Japan, 3 August 2012, collected by Masanori Sato. NIBRIV0000787942, 1 ind., Saigogawa River, Shimabara, Nagasaki Prefecture, Japan, 3 August 2012, collected by Masanori Sato.

Diagnosis

Bar-shaped paragnaths (usually more than 3, outermostbars longest) with uneven length arranged in single transverse row on area VI. Area V usually with 3 paragnaths in a triangular arrangement. Dorsal cirri subequal to or slightly longer than dorsal notopodial ligules. Notoacicular papilla present. Notopodial prechaetal and neuropodial postchaetal lobes absent.

Description of atokes

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum with pigmentation of pale green color in live individuals, with pale pigmentation of cream color in preserved ones.

Prostomium pyriform, wider than long, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with palpophores and shorter round palpostyles. Two pairs of eyes arranged trapezoidally; anterior pair reniform and slightly larger than posterior pair; gap of anterior pair wider than posterior pair (Fig. 87A).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetigers 3–10 in most specimens (Fig. 87B).

Proboscis with pair of brown amber jaws, each with 5–8 teeth of serrated inner margin (Fig. 87A, B). Conical paragnaths present on both maxillary and oral rings except area VI; uneven length of Bar-shaped paragnaths present on each side of area VI; paragnaths on oral ring slightly larger than those on maxillary ring. Paragnath numbers and arrangements as follows: area I, 3 in irregular clusters; area II, 16–30 on left and 17–30 on right arranged in elongate patches; area III, 24–36 in rectangular patch with lateral groups; area IV, 26–33 on left and 26–35 on right arranged in crescentic patches; area V, 3 in basically triangular arrangement; area VI, 3–7 on both left and right with uneven length of bar-shape paragnaths in single transverse row on each side; areas VII–VIII, 28–41 in two or three irregular rows in central area (area VII) and single row in lateral sides (area VIII) (Fig. 87A, B; Table 50).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with reduced notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular ligule with superior and inferior lobes, ventral ligule, and ventral cirrus.

Notopodia consisting of dorsal cirrus, dorsal ligule, notoacicular papilla, and ventral ligule in biramous parapodia (Fig. 87C, D). Dorsal cirri slender, slightly longer than (or same in length as) notopodial dorsal ligule in anterior and posterior parapodia. Notopodial dorsal ligule subtriangular in anterior parapodia, gradually reducing toward posteriorly (Fig. 87D), not markedly expanding posteriorly; notoacicular papilla present from anterior parapodia especially large specimens, gradually reducing posteriorly. Notopodial ventral ligule subconical, subequal to notopodial dorsal ligule in anterior chaetigers, smaller than notopodial dorsal ligule in posterior chaetigers (Fig. 87D).

Neuropodia consisting of acicular ligule, ventral ligule, and ventral cirrus throughout. Superior and inferior lobes present in neuropodial acicular ligule in anterior and middle parapodia (Fig. 87C), gradually reduced posteriorly (Fig. 87D). Neuropodial ventral ligule oval in anterior chaetigers, digitate in posterior chaetigers. Ventral cirri slender, smaller than neuropodial ventral ligules throughout (Fig. 87C, D).

Notochaetae all homogomph spinigers; blades long with finely serrated edge. Upper neurochaetae consisting of long heterogomph falcigers with half serrated blades at anterior position, and homogomph spinigers with long serrated blades at posterior position. Lower neurochaetae consisting of long heterogomph falcigers with half serrated blades at both anterior and posterior positions, and heterogomph spinigers with long serrated blades at superior posterior position.

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers in *Perinereis mictodonta* are summarized in Table 49.

Habitats

Intertidal. In muddy sand to gravely sand substrate, under rocks, associated with oyster beds.

Distribution

Type locality: Enoshima near Yokohama, Japan. Eastern Asia (China, Taiwan, Korea, Japan) (Fig. 88).

Molecular data

The COI sequences obtained from 23 individuals (Table 4, Appendix 2).

Remarks

See remarks part of *Perinereis wilsoni* species complex on page 256.

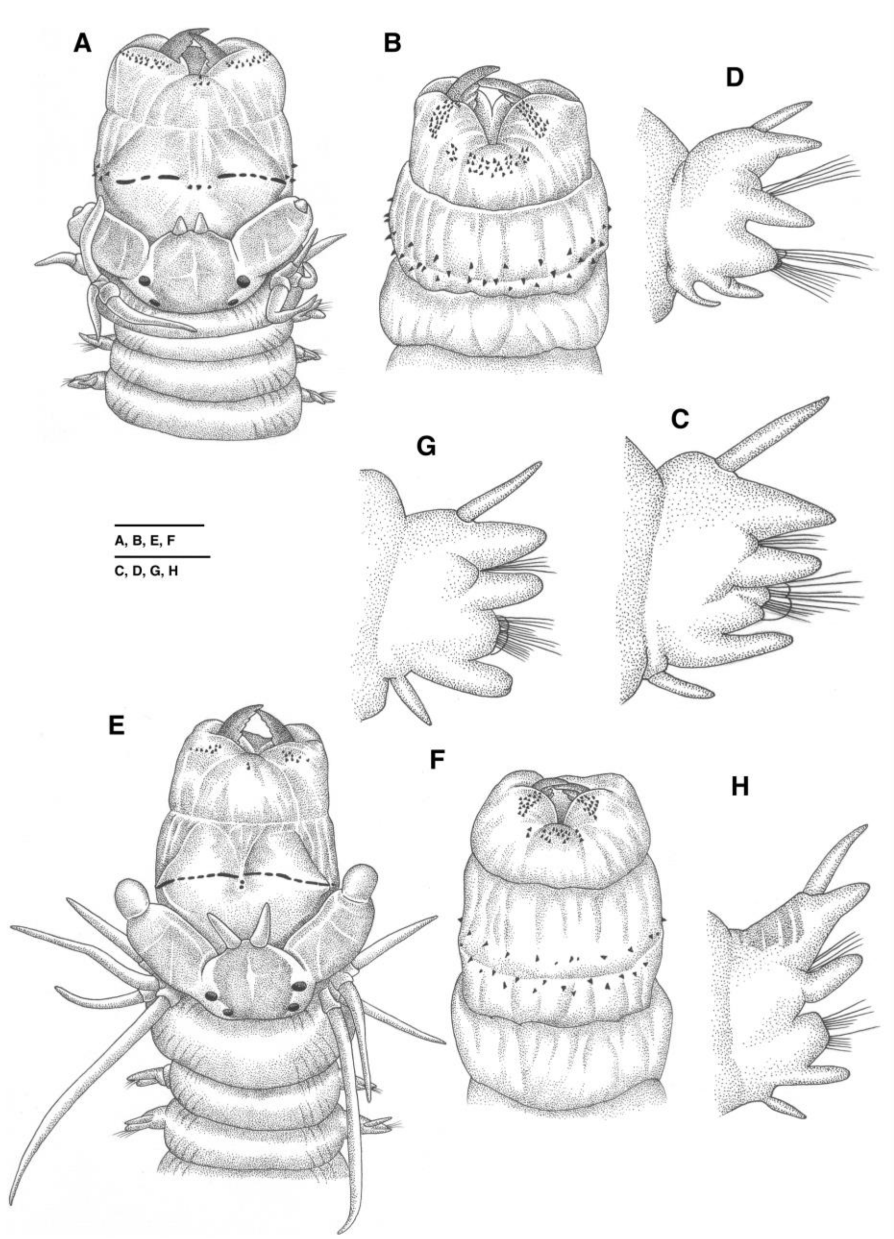

Fig. 87. *Perinereis mictodonta* (Marenzeller, 1879), (A, B) Dorsal and ventral views of anterior end with the everted proboscis. (C) Anterior view of anterior parapodium. (D) Anterior view of posterior parapodium. *Perinereis wilsoni* Glasby and Hsieh, 2006, (E, F) Dorsal and ventral view of anterior end with the everted proboscis. (G) Anterior view of anterior parapodium. (H) Anterior view of posterior parapodium. Scale bars: 2 mm in (A, B, E, F); 0.4 mm in (C, D, G, H).

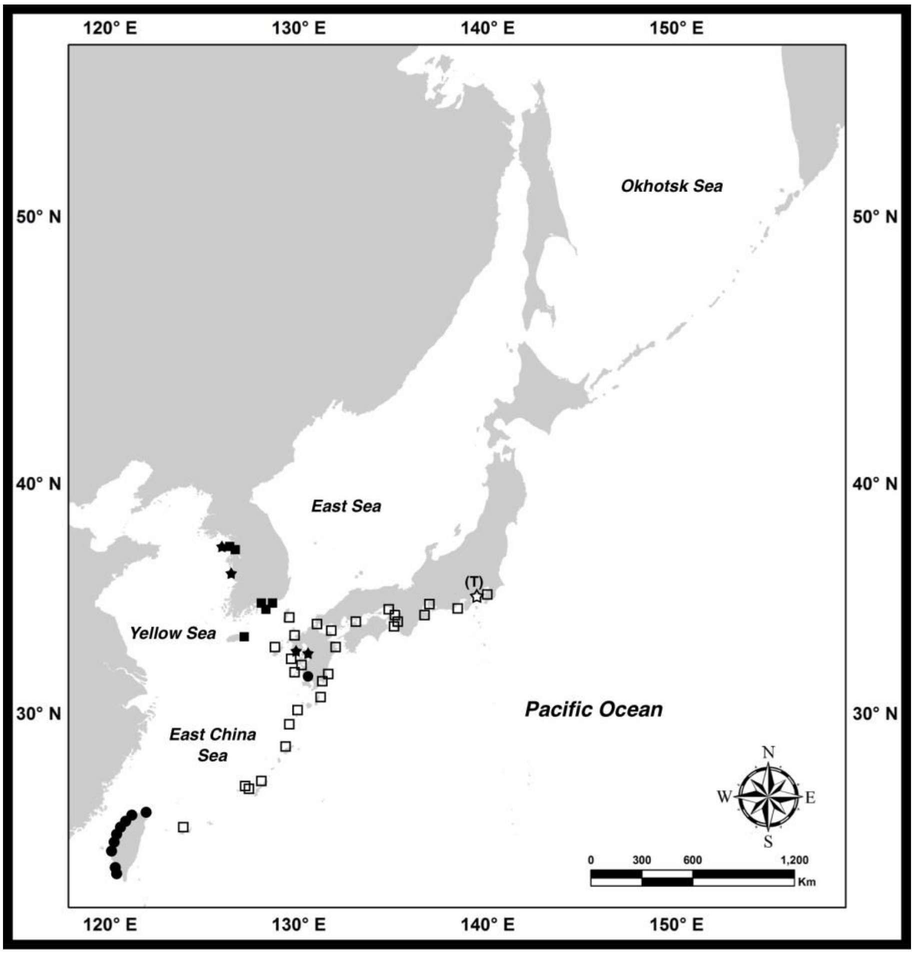

Fig. 88. Distribution of *Perinereis mictodonta* (Marenzeller, 1879) in Northeast Asia based on the present study (★) and the literature. (☆) Marenzeller (1879), (●) Glasby and Hsieh (2006), (■) Park and Kim (2007), (□) Sakaguchi (2015, unpublished data). (T) Type locality.

Table 49. Variation in paragnath numbers in area I to VIII on proboscis of *Perinereis mictodonta* (Marenzeller, 1879). Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

<table>
<tr><th>Locality</th><th>I</th><th>II(L)</th><th>II(R)</th><th>III</th><th>IV(L)</th><th>IV(R)</th><th>V</th><th>VI(L)</th><th>VI(R)</th><th>VII–VIII</th></tr>
<tr><td>Korea (n=14)
(Present study)</td><td>3</td><td>16–27
(21±3.4)</td><td>17–29
(22.8±3.7)</td><td>26–36
(31.4±3.2)</td><td>26–33
(30.4±2.2)</td><td>26–32
(28.9±2)</td><td>3</td><td>3–7
(5.3±0.9)</td><td>3–7
(4.9±1.1)</td><td>28–41
(35.6±4.1)</td></tr>
<tr><td>Korea (n=49)
(Park & Kim, 2007)</td><td>1–5
(2.5±1.2)</td><td colspan="2">13–37
(23.9±4.8)</td><td>20–36
(27.8±4.1)</td><td colspan="2">23–44
(30.6±4.7)</td><td>1–5
(3±0.5)</td><td colspan="2">2–7
(4.5±1.3)</td><td>26–44
(37.2±3.2)</td></tr>
<tr><td>Japan (n=3)
(Present study)</td><td>3</td><td>27–30
(28±1.7)</td><td>29–30
(29.3±0.6)</td><td>24–30
(27±3)</td><td>30–31
(30.7±0.6)</td><td>27–35
(31±4)</td><td>3</td><td>4–5
(4.3±0.6)</td><td>4</td><td>33–36
(34.7±1.5)</td></tr>
</table>

21. *Perinereis shikueii* Glasby and Hsieh, 2006 (Figs. 89–91)

Perinereis shikueii Glasby and Hsieh, 2006: 565–568, fig. 8a–f; Sakaguchi, 2015: 116–123, figs. 31–32.

Perinereis brevicirris: Wu, 1976: 71–72, fig. 11a–d (in part).

Materials examined

Non-type materials

NIBRIV000022181, 10 inds., Ganghwado Is., Ganghwa-gun, Incheon-si, Korea, 12 April 2013, collected by Jong-Wui Lee. NIBRIV000022180, 2 inds., Dae-ri, Wido-myeon, Buan-gun, Jeollabuk-do, Korea, 8 May 2000, collected by Jong-Wui Lee and Hyun-Jin Oh. NIBRIV000022201, 1 ind., Wonchang-dong, Seo-gu, Incheon-si, Korea, 8 October 1999, collected by In-Soon Seo and Ye Eun. NIBRIV0000810312, 1 ind., Yeongu-ri, Hacheong-myeon, Geoje-si, Gyeongsangnam-do, Korea, 22 May 2013, collected by Taeseo Park. NIBRIV0000787945, 1 ind., Nanaura, Kashima, Saga Prefecture, Japan, 25 April 2009, collected by Masanori Sato.

Diagnosis

Short even-length bar-shaped paragnaths (5–10) arranged in single transverse row on each side of area VI on proboscis. Area V with usually 3 conical paragnaths arranged in a transverse line or flat triangle patch, located close to row of area VI (Sakaguchi, 2015). Notoacicular papilla present in anterior and middle parapodia. Notopodial prechaetal and neuropodial postchaetal lobes absent. (modified from unpublished data of Sakaguchi, 2015).

Description of atokes

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Colour in preserved specimens whitish cream.

Prostomium pyriform, wider than long, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with palpophores and shorter round palpostyles. Two pairs of eyes arranged trapezoidally; anterior pair reniform and slightly larger than posterior pair; gap of anterior pair wider than posterior pair (Fig. 89A).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetigers 4–12.

Proboscis with pair of brown amber jaws, each with 4–8 teeth of serrated inner margin. Conical paragnaths with pointed tip present on both maxillary and oral rings except area VI; uneven length of bar-shaped paragnaths present on each side of area VI; paragnaths on oral ring slightly larger than those on maxillary ring. Paragnath numbers and arrangements as follows: area I, 1–6 in diamond shape; area II, 11–33 on right and 19–33 on left arranged in elongate patches; area III, 16–27 in rectangular central patch with lateral groups of 2–9 on each side; area IV, 22–37 on right and 21–35 on left arranged in crescentic patches; area V, 2–5 in transverse row or flat triangle patch located close to row of area VI; area VI, 5–10 on each side with uneven length of bar-shape paragnaths in single transverse row; areas VII–VIII, 33–43 in two or three irregular rows in central area (area VII) and single row in lateral sides (area VIII) (Fig. 89A, B; Table 51).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with reduced notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular ligule with superior and inferior lobes, ventral ligule, and ventral cirrus (Fig. 89C).

Notopodia consisting of dorsal cirrus, dorsal ligule, notoacicular papilla, and ventral ligule in biramous parapodia (Fig. 89C–F). Dorsal cirri slender, longer than notopodial dorsal ligule in anterior and posterior parapodia. Notopodial dorsal ligule subconical in anterior parapodia (Fig. 89D), gradually reducing toward posteriorly (Fig. 89E, F), not markedly expanding posteriorly; notoacicular papilla present from anterior parapodia especially large specimens. Notopodial ventral ligule subconical, slightly shorter than notopodial dorsal ligule throughout (Fig. 89D–F).

Neuropodia consisting of acicular ligule, ventral ligule, and ventral cirrus throughout. Superior and inferior lobes present in neuropodial acicular ligule in anterior and middle parapodia (Fig. 89D, E), gradually reduced posteriorly (Fig. 89F). Neuropodial ventral ligules digitate throughout. Ventral cirri slender, smaller than neuropodial ventral ligules throughout (Fig. 89D–F).

Notochaetae all homogomph spinigers; blades long with finely serrated edge (Fig. 89G). Upper neurochaetae consisting of long heterogomph falcigers (Fig. 89I) with half serrated blades at anterior position, and homogomph spinigers (Fig. 89H) with long serrated blades at posterior position. Lower neurochaetae consisting of long heterogomph falcigers (Fig. 89J) with half serrated blades at both anterior and posterior positions, and heterogomph spinigers with long serrated blades (Fig. 89K) at superior posterior position.

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri (modified from Sakaguchi, 2015).

Variation in paragnath number

Paragnath numbers in *Perinereis shikueii* are summarized in Table 51.

Habitats

Under stones in intertidal mudflats in the upper intertidal zone.

Distribution

Type locality: Chuwei, Taiwan. Northeast Asia (Taiwan, Southern part of Japan, Korea (new record from this study)) (Fig. 90).

Molecular data

The COI sequences obtained from four individuals (Table 4, Appendix 2).

Remarks

Perinereis shikueii is similar to *P. nuntia* (Savigny in Lamarck, 1818) (type locality: Gulf of Suez) in terms of having short and even-length bars in area VI, but different from *P. nuntia* in terms of having a large number of paragnaths in maxillary ring (area I–IV). *Perinereis shikueii* is also similar to *P. mictodonta* and *P. wilsoni* complex. However, *P. shikueii* differs from *P. mictodonta* and *P. wilsoni* complex in the following diagnostic characteristics: (1) having fewer paragnaths in area IV, (2) having large number of bars in area VI, and (3) having straight transverse arrangement of paragnaths in area V (Fig. 89A).

Comparisons of DNA sequences of COI among *P. shikueii*, *P. mictodonta*, and *P. wilsoni* complex supported results of morphological examination (Fig. 97, Table 50). This species is first reported in Korea from this study.

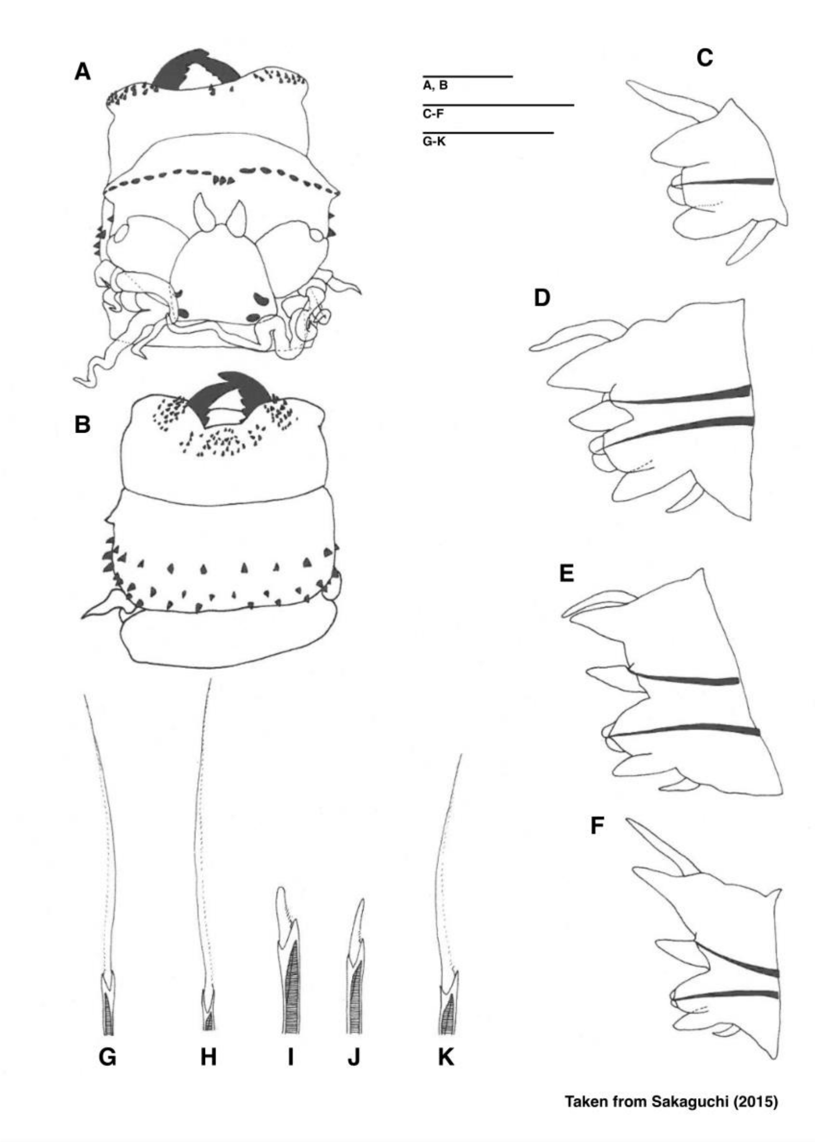

Fig. 89. *Perinereis shikueii* Glasby and Hsieh, 2006, atoke. (A, B) Dorsal and ventral views of anterior end. (C–F) Posterior view of parapodium 2 (C); 15 (D, anterior), 50 (E, middle), 90 (F, posterior). (G) Homogomph spiniger from notochaetae in parapodium 15. (H) Homogomph spiniger from upper neurochaetae in parapodium 15. (I) Heterogomph falciger from upper neurochaetae in parapodium 15. (J) Heterogomph falciger from lower neurochaetae in parapodium 15. (K) Heterogomph spiniger from lower neurochaetae in parapodium 15. Scale bars: 1 mm in (A–F); 0.1 mm in (G–K). Taken from Sakaguchi (2015).

Table 50. Mean pairwise genetic distances (K2P distance) based on COI sequences among *Perinereis shikueii* Glasby and Hsieh, 2006, *P. mictodonta* (Marenzeller, 1879), and *P. Wilsoni* Glasby and Hsieh, 2006 complex. n = individuals.

Species	*P. shikueii*	*P. mictodonta*	*P. wilsoni* complex
P. shikueii (n=4)	0.000	0.164	0.177
P. mictodonta (n=23)	0.164	0.002	0.191
P. wilsoni complex (n=25)	0.177	0.191	0.053

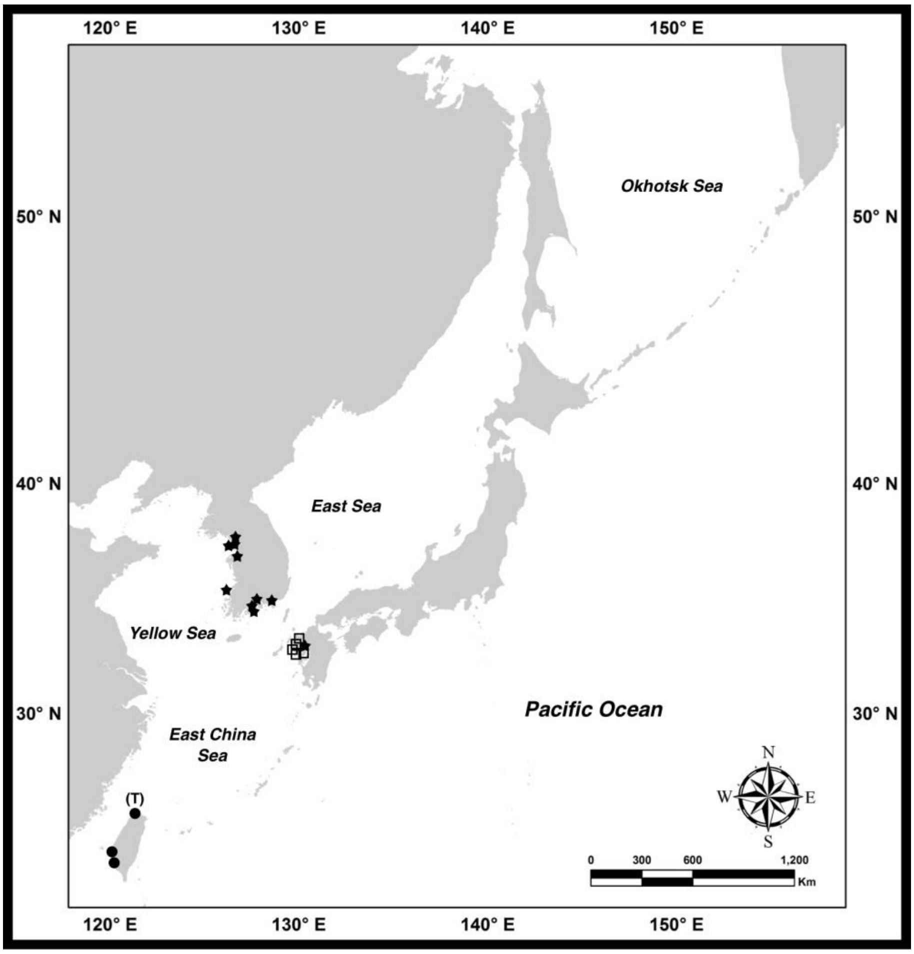

Fig. 90. Distribution of *Perinereis shikueii* Glasby and Hsieh, 2006 in Northeast Asia based on the present study (★) and the literature. (●) Glasby and Hsieh (2006), (□) Sakaguchi (2015, unpublished data). (T) Type locality.

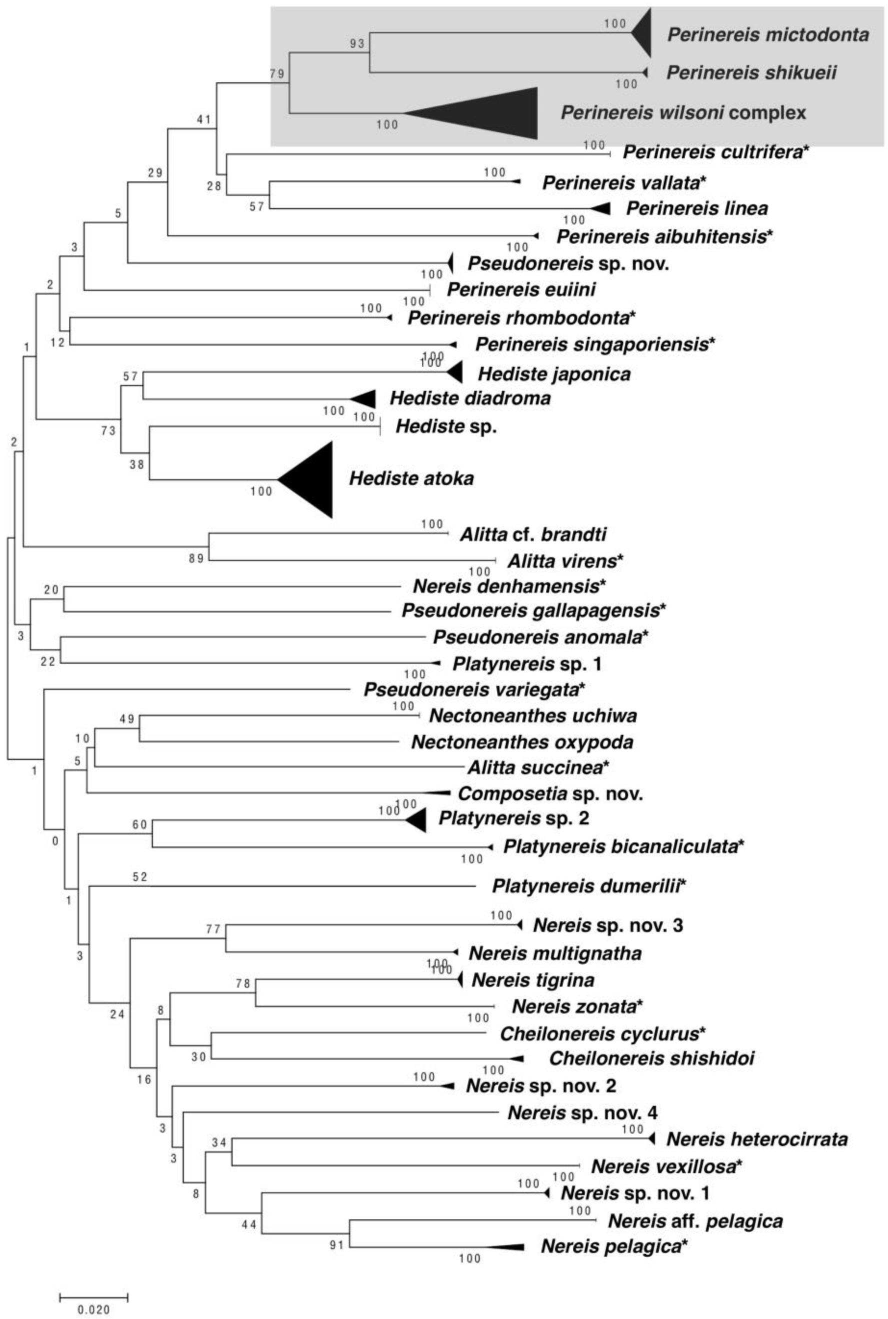

Fig. 91. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray box represents the difference among *Perinereis shikueii* Glasby and Hsieh, 2006, *P. mictodonta* (Marenzeller, 1879), and *P. wilsoni* Glasby and Hsieh, 2006 complex.

Table 51. Variation in paragnath numbers in area I to VIII on proboscis of *Perinereis shikueii* Glasby and Hsieh, 2006. Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Locality (References)	**I**	**II(L)**	**II(R)**	**III (total)**	**III (lateral)**	**IV(L)**	**IV(R)**	**V**	**VI(L)**	**VI(R)**	**VII–VIII**
Japan (n=1) (Present study)	5	22	21	28	present	26	25	4	8	7	40
Japan (n=29) (Sakaguchi, 2015 unpublished data)	1–6 (4.2±1.2)	19–33 (25±3.2)		22–38 (31.3±4.7)	present	22–37 (29.5±3.7)		2–5 (3.2±0.6)	5–10 (8.3±1.4)		33–43 (39.1±2.3)
Taiwan (n=32) (Glasby & Hsieh, 2006)	2–7 (4.6±1.3)	17–27 (21.7±3.4)		18–19 (23.3±2.7)	present	21–35 (25.3±5.1)		3–4 (3.1±0.2)	4–10 (7.1±1.6)		34–52 (38.4±3.5)
Korea (n=13) (Present study)	1–8 (4.7±1.7)	18–26 (22.2±2.2)	20–26 (22.5±2.1)	26–37 (31.5±3.2)	present	25–40 (29.1±4.2)	26–45 (30.4±5.1)	2–6 (3.3±1)	7–12 (8.4±1.3)	6–10 (8.4±1.3)	33–43 (39.3±3.1)

22. *Perinereis wilsoni* Glasby and Hsieh, 2006 species complex (Figs. 87E–H, 92, 93)

Perinereis wilsoni: Park and Kim 2007: 80–83, figs. 2E–H, 3B, 4B; Sakaguchi, 2015: 124–135, figs. 33–34.

Materials examined

Non-type materials

NIBRIV0000787935, 9 inds., muddy tidal flat, Ojo-ri, Seongsan-eup, Seogwipo-si, Jeju-do Korea, 16 February 2012, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000810293, 1 ind., muddy tidal flat, Hacheong-myeon, Geoje-si, Gyeongsangnam-do, Korea, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000810292, 2 inds., Yeonpyeongdo Is., Yeonpyeong-myeon, Ongjin-gun, Incheon-si, Korea, 13 February 2012, collected by Pyung-Gang Lee, fixed in 80% ethanol. NIBRIV0000801058, 3 ind., Geomundo Is., Seodo-ri, Samsan-myeon, Yeosu-si, Jeollanam-do, Korea, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787937, 2 inds., Sin-gawa River, Kagoshima city, Kyushu, Japan, 30 June 2013, collected by Masanori Sato, fixed in 80% ethanol. NIBRIV0000801060, 1 ind., Ganggu Harbor, Ganggu-myeon, Yeongdeok-gun, Gyengsangbuk-do, Korea, 27 August 2014, collected by Ji-Hun Song, fixed in 80% ethanol. NIBRIV0000810296, 2 inds., Biin-myeon, Seocheon-gun, Chungcheongnam-do, Korea, 30 March 2012, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000801061, 1 ind., Hacheong-myeon, Geoje-si, Gyeongsangnam-do, Korea, 19 March 2012, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787936, 5 inds., Lamma Is., Yung Shue Wan Village, Hong Kong, 15 March 2013, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787938, 2 inds., Hakamagoshi, Sakurajima, Kagoshima Prefecture, Japan, 24 August 2013, collected by Masanori Sato, fixed in 80% ethanol. NIBRIV0000801059, 1 ind., Sangye-dong, Seogwipo-si, Jeju-do, Korea, 20 May 2015, collected by Seul Yi and Ye Eun, fixed in 80% ethanol.

Diagnosis

Bar-shaped paragnaths (usually more than 3, outermostbars longest) with uneven length arranged in single transverse row on area VI. Area V usually with 1 to 2 conical paragnath. Dorsal cirri about 1.5 times longer than notopodial dorsal ligules in anterior chaetigers, increasing to about twice longer than notopodial dorsal ligules in posterior chaetigers. Notoacicular papilla present. Notopodial prechaetal and neuropodial postchaetal lobes absent.

Description of atokes

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum with pigmentation of pale green color in live individuals, with pale pigmentation of cream color in preserved ones.

Prostomium pyriform, wider than long, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with palpophores and shorter round palpostyles. Two pairs of eyes arranged trapezoidally; anterior pair reniform and slightly larger than posterior pair; gap of anterior pair wider than posterior pair (Fig. 87E).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetigers 6–12 in most specimens (Fig. 87F).

Proboscis with pair of brown amber jaws, each with 7–8 teeth of serrated inner margin (Fig. 87E, F). Conical paragnaths present on both maxillary and oral rings except area VI; uneven length of bar-shaped paragnaths present on each side of area VI; paragnaths on oral ring slightly larger than those on maxillary ring. Paragnath numbers and arrangements as follows: area I, 1–5; area II, 7–31 on left and 6–32 on right arranged in elongate patches; area III, 9–37 in rectangular patch with lateral groups; area IV, 14–44 on left and 17–43 on right arranged in crescentic patches; area V, 1–4; area VI, 2–12 on left and 3–11 on right with uneven length of bar-shape paragnaths in single transverse row on each side; areas

VII–VIII, 20–81 in two or three irregular rows in central area (area VII) and single row in lateral sides (area VIII) (Fig. 87E, F; Table 53).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with reduced notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular ligule with superior and inferior lobes, ventral ligule, and ventral cirrus.

Notopodia consisting of dorsal cirrus, dorsal ligule, notoacicular papilla, and ventral ligule in biramous parapodia (Fig. 87G, H). Dorsal cirri slender, longer than notopodial dorsal ligule in anterior and posterior parapodia. Notopodial dorsal ligule subtriangular in anterior parapodia, gradually reducing toward posteriorly (Fig. 87H), not markedly expanding posteriorly; notoacicular papilla present from anterior parapodia especially large specimens. Notopodial ventral ligule subconical, subequal to or slightly longer than notopodial dorsal ligule in anterior chaetigers, smaller than notopodial dorsal ligule in posterior chaetigers (Fig. 87H).

Neuropodia consisting of acicular ligule, ventral ligule, and ventral cirrus throughout. Superior and inferior lobes present in neuropodial acicular ligule in anterior and middle parapodia (Fig. 87G), gradually reduced posteriorly (Fig. 87H). Neuropodial ventral ligules digitate throughout. Ventral cirri slender, smaller than neuropodial ventral ligules throughout (Fig. 87G, H).

Notochaetae all homogomph spinigers; blades long with finely serrated edge. Upper neurochaetae consisting of long heterogomph falcigers with half serrated blades at anterior position, and homogomph spinigers with long serrated blades at posterior position. Lower neurochaetae consisting of long heterogomph falcigers with half serrated blades at both anterior and posterior positions, and heterogomph spinigers with long serrated blades at superior posterior position.

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers in *Perinereis wilsoni* species complex are summarized in Table 53.

Habitats

Intertidal. In muddy sand to gravely sand substrate, under rocks.

Distribution

Type locality: Pitou, Taiwan. East Asia (China, Hong Kong, Taiwan, Korea, Japan) (Fig. 92).

Molecular data

The COI sequences data obtained from 25 individuals (Table 4, Appendix 2).

Remarks

Fauvel (1932) relegated *Nereilepas brevicirris* Grube, 1867 to a variety of *Perinereis nuntia* and *P. nuntia* var. *brevicirris* based on material housed in the Indian Museum, Calcutta. Wilson and Glasby (1993) reexamined the type specimen of *N. brevicirris* and concluded that it was the same species as *Nereis vallata* Glube, 1858. This taxon, now referred to as *P. vallata* (Grube, 1858), occurs only on southern hemisphere shore. Recently, Glasby and Hsieh (2006) have reexamined *P. nuntia* var. *brevicirris* (= *P. brevicirris*) and *P. nuntia* var. *vallata* (= *P. nuntia vallata* or *P. vallata*) from the northern hemisphere and tropical shores based on literatures and materials from Northeast Asia (Taiwan, China, Korea, and Japan) and synonymized with *P. mictodonta* and *P. wilsoni,* respectively.

Perinereis mictodonta is most similar to *P. wilsoni*. According to Glasby and Hsieh (2006), these two species cannot be distinguished from each other by paragnath counts or by morphology of male and female epitokes. Although these two species are morphologically very similar, they can be distinguished by DNA sequences of ITS and COI

(Chen et al., 2002; Park and Kim, 2007).

In the present study, these two species were distinguished by comparison of DNA sequences of COI. *Perinereis mictodonta* is represented by a single clade with low intra specific variation (Fig. 93A-1, Table 52) whereas *P. wilsoni* is represented by separate clades with high intra specific variation (Fig. 93B, Table 52). Hence, clades of *P. wilsoni* are likely to represent the present specimens comprised of cryptic species. Further study is needed to elucidate morphology characteristics of these populations.

Table 52. Mean pairwise genetic distances (K2P distance) based on COI sequences between *Perinereis wilsoni* Glasby and Hsieh, 2006 species complex and *P. mictodonta* (Marenzeller, 1879). n = individuals.

Species	*P. wilsoni* species complex	*P. mictodonta*
P. wilsoni species complex (n=25)	0.053	0.191
P. mictodonta (n=23)	0.191	0.002

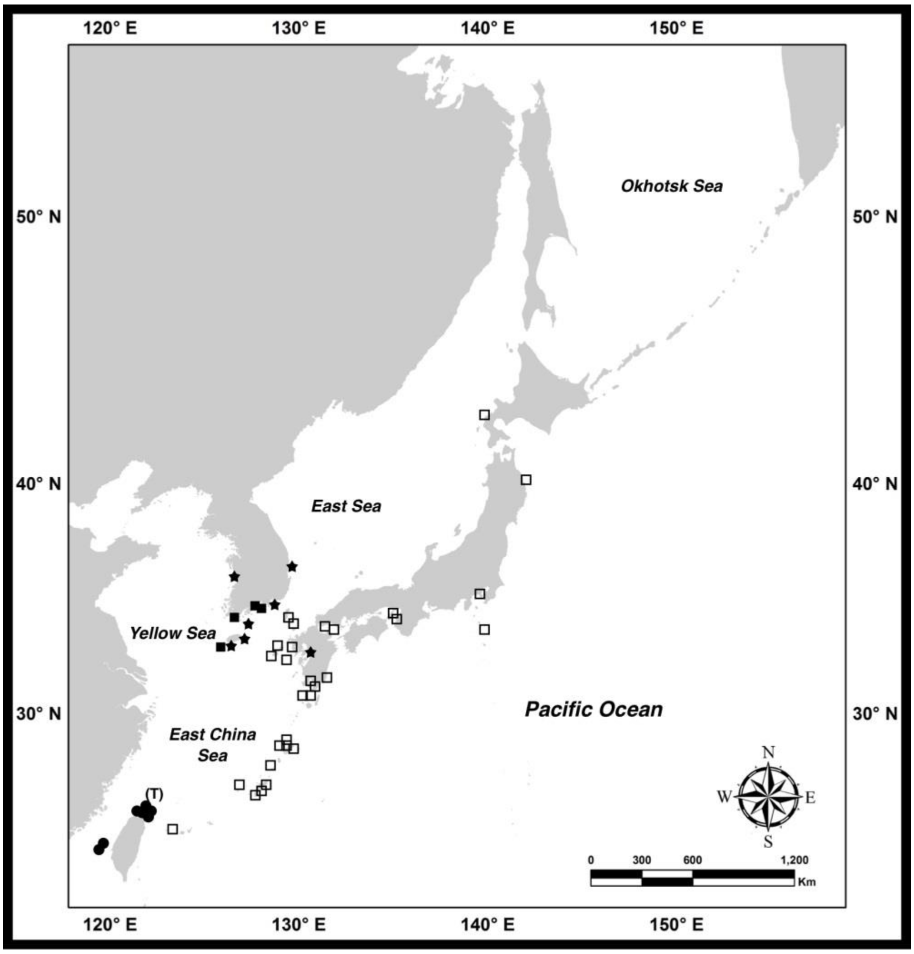

Fig. 92. Distribution of *Perinereis wilsoni* Glasby and Hsieh, 2006 species complex in Northeast Asia based on the present study (★) and the literature. (●) Glasby and Hsieh (2006), (■) Park and Kim (2007), (□) Sakaguchi (2015, unpublished data). (T) Type locality.

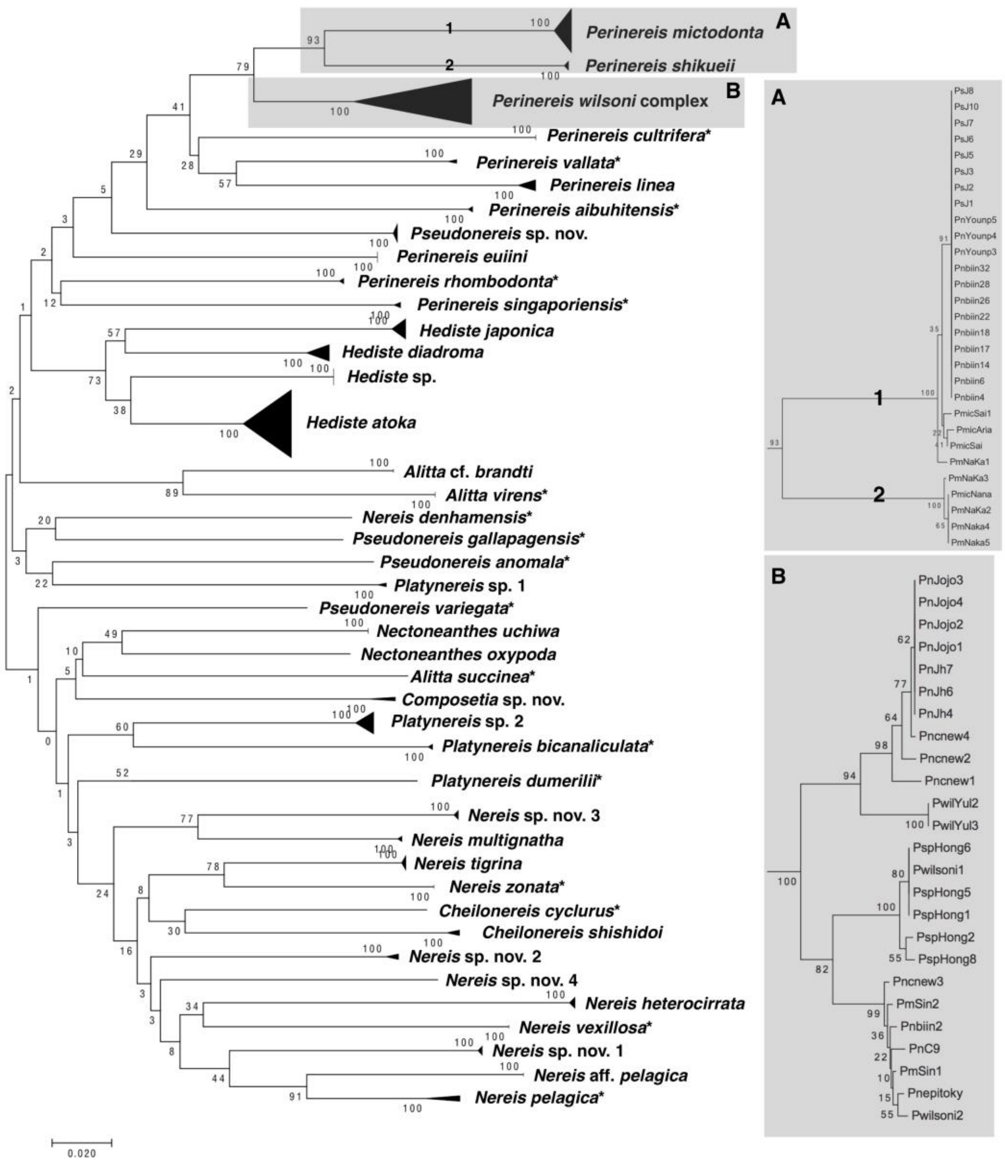

Fig. 93. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. A1: *Perinereis mictodonta* (Marenzeller, 1879), A2: *P. shikueii* Glasby and Hsieh, 2006, B: *P. wilsoni* Glasby and Hsieh, 2006 species complex.

Table 53. Variation in paragnath numbers in area I to VIII on proboscis of *Perinereis wilsoni* Glasby and Hsieh, 2006 species complex. Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Taxon	I	II*	III (total)	III (lateral)	IV*	V	VI*	VII–VIII
P. wilsoni Type 1 (n=6)	1–4 (2.5±1)	6–28 (17.1±10)	11–37 (23.7±10.4)	1–5 (2.8±1.5)	18–41 (27.4±7.8)	1–4 (2.8±1)	4–12 (6.4±2.5)	27–36 (31±4.4)
P. wilsoni Type 2 (n=3)	1–2 (1.3±0.6)	6–10 (8.2±1.5)	9–15 (12±3)	0–2 (1±0.6)	16–22 (19.5±2.4)	1–3 (1.7±1.2)	3–7 (4.8±1.5)	20–26 (24±3.5)
P. wilsoni Type 3 (n=7)	1–5 (3±1.6)	8–32 (20.4±7.9)	14–37 (28.1±7.9)	2–5 (3.5±1.2)	14–44 (32.1±9.8)	3–4 (3.1±0.4)	3–7 (5.9±1.2)	31–81 (42.1±17.5)
P. wilsoni Type 4 (n=5)	2–4 (2.6±0.9)	14–24 (20.9±3.6)	15–28 (21.8±4.7)	2–5 (2.9±1.1)	20–32 (26.1±4.1)	3–4 (3.2±0.4)	2–6 (3.6±1.2)	33–38 (34.8±2.5)
P. wilsoni Type 5 (n=3)	1–2 (1.3±0.6)	7–11 (9±1.4)	12–20 (15.3±4.2)	1–3 (2±0.6)	17–31 (22.8±6)	1–3 (1.7±1.2)	5–8 (6.3±1.2)	24–31 (26.7±3.9)
P. wilsoni species complex (n=24, total)	1–5 (2.4±1.2)	6–32 (16.7±8.1)	9–37 (22.1±8.9)	0–5 (2.7±1.4)	14–44 (27±8.1)	1–4 (2.7±1)	2–12 (5.5±1.9)	20–81 (33.6±11.4)

*Paragnath numbers on each side.

Genus *Platynereis* Kinberg, 1865

Platynereis Kinberg, 1865: 177.

Type species: *Platytnereis magalhaensis* Kinberg, 1865 (designated by Hartman, 1948).

Diagnosis

Prostomium with entire anterior margin, one pair of antennae, one pair of biarticulated palps with conical palpostyles, four pairs of tentacular cirri with distinct cirrophores. Two pairs of eyes. One apodous anterior segment, greater than length of chaetiger 1. Maxillary ring of pharynx, pectinate paragnaths: areas I−II, absent; III−IV, present. Oral ring, pectinate paragnaths: area V, absent; VI, present; VII−VIII, present, arranged in isolated patches or in one or more irregular lines forming a continuous band. Dorsal notopodial ligule similar in size on anterior and posterior chaetigers. Notopodial prechaetal lobe present, smaller than dorsal notopodial ligule on anterior chaetigers, usually reduced or absent posteriorly. Dorsal cirrus mid-dorsally to subterminally attached to dorsal notopodial ligule on posterior chaetigers, lacking basal cirrophore. Neuropodial postchaetal lobe present or absent. Notoaciculae absent from chaetigers 1 and 2. Notochaetae: homogomph spinigers present; homogomph falcigers present or absent, present as a simple chaeta or articulated throughout. Neurochaetae, dorsal fascicle: homogomph spinigers and heterogomph falcigers present, blades serrated. Neurochaetae, ventral fascicle: heterogomph spinigers present, heterogomph falcigers with long blades of anterior chaetigers present (Bakken, 2007).

23. *Platynereis* sp. 1 (Figs. 94, 96)

Materials examined

Non-type materials

NIBRIV0000787912, 1 ind., associated with sessile organism, Namyang-ri, Seo-myeon, Ulleung-gun, Gyeongsangbuk-do, Korea, 22 June 2014, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787917, 1 ind., associated with sessile organism in artificial underwater reef, Geomundo Is., Samsan-myeon, Yeosu-si, Jeollanam-do, Korea, 25 April 2013, collected by Taeseo Park, fixed in 80% ethanol.

Habitats

Subtidal rocky shores, associated with sessile organisms.

Distribution

Korea (Fig. 94).

Molecular data

The COI sequences obtained from two individuals (Table 4, Appendix 2).

Remarks

See remarks part of *Platynereis* sp. 2 on page 271.

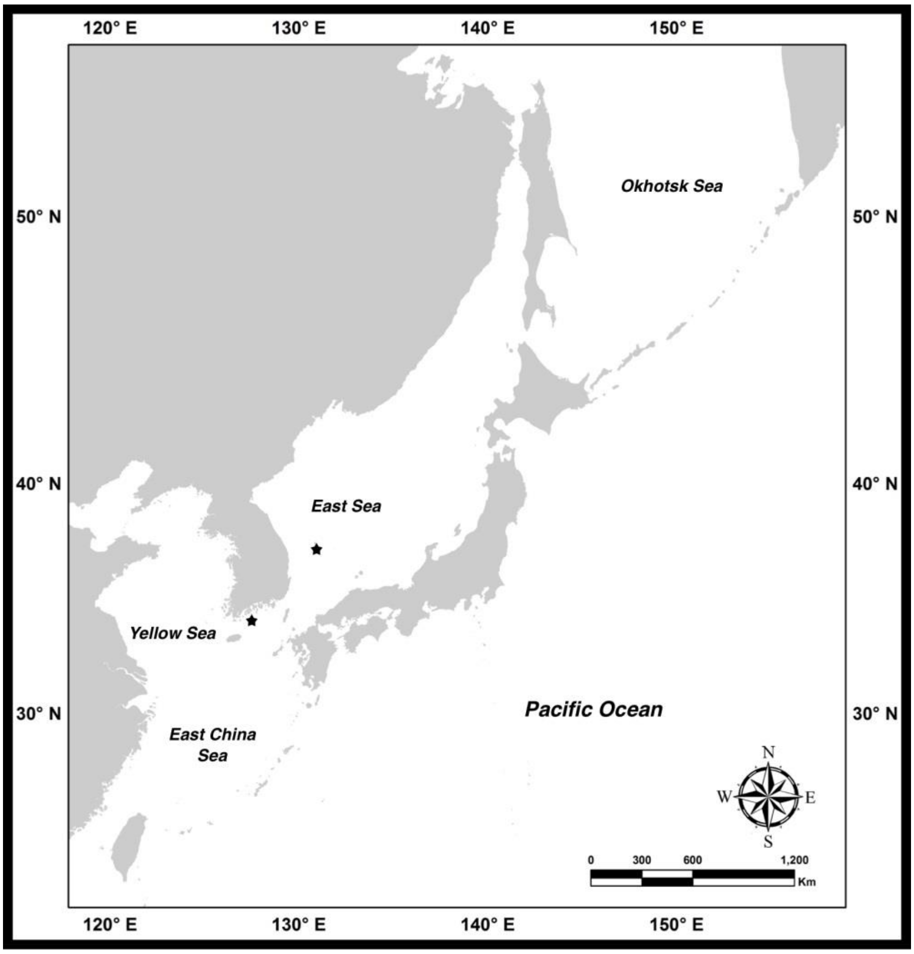

Fig. 94. Distribution of *Platynereis* sp. 1 in Northeast Asia based on the present study (★)

24. *Platynereis* sp. 2 (Figs. 95, 96)

Materials examined

Non-type materials

NIBRIV0000787909, 1 ind., associated with sessile organism, Namae-ri, Hyeonnam-myeon, Yangyang-gun, Gangwon-do, Korea (37°56′22″N, 128°48′7″E), 10 June 2013, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787916, 1 ind., Geomundo Is., Seodo-ri, Samsan-myeon, Yeosu-si, Jeollanam-do, Korea, 25 April 2013, collected by Taeseo Park, fixed in 70% ethanol. NIBRIV0000787914, 1 ind., associated with oysters in intertidal area, Seodo-ri, Samsan-myeon, Yeosu-si, Jeollanam-do, Korea (34°3′20″N, 127°17′36″E), 24 April 2013, collected by Taeseo Park, Seul Yi and Sang-Hwi Lee, fixed in 80% ethanol. NIBRIV0000787911, 1 ind.; NIBRIV0000787913, 1 ind., subtidal rocky area in depth of 17.7 m, Gapado Is., Gapa-ri, Daejeong-eup, Seogwipo-si, Jejudo Is., Korea, 2 March 2016, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000787918, 2 inds., associated with sessile organism, Dokdo Is., Dokdo-ri, Ulleung-eup, Ulleung-gun, Gyeosangbuk-do, Korea, 6 July 2015, collected by Taeseo Park by Scuba diving, fixed in 80% ethanol. NIBRIV0000787915, 2 inds., associated with sessile organism, Oedo Is., Irun-myeon, Geoje-si, Gyeongsangnam-do, Korea (33°29′41″N, 126°25′25.7″E), 6 January 2012, collected by Taeseo Park, fixed in 80% ethanol.

Habitats

Subtidal rocky shores, associated with sessile organisms.

Distribution

Korea (Fig. 95).

Molecular data

The COI sequence data obtained from 11 individuals (Table 4, Appendix 2).

Remarks

Platynereis bicanaliculata (type locality: the east Pacific Ocean, Canada) has been known as widely distributed species, recorded from the east (Northeast Asia) and west (Canda, USA, and Mexico) coasts of the north Pacific (Baird, 1863; Ehlers, 1868; Treadwell, 1914; Wu, 1967; Imajima, 1972; Wu et al., 1985; Paik, 1977). However, the comparison of DNA sequences of COI from this study revealed significant difference between the east (*P. bicanaliculata*) and west (*P.* sp. 1, 2) north Pacific populations (Fig. 96, Table 54). Moreover, west north Pacific (Northeast Asia) populations represented two different clades (mean p-distance: 0.211) (Fig. 96, Table 54).

Based on the results of DNA analysis in this study the existence of new species of *Platynereis* from Northeast Asian region is likely. However, further study of the morphology of this population is required, including comparison with specimens from wide ranges from the west north Pacific regions.

Table 54. Mean pairwise genetic distances (K2P distance) based on COI sequences among *Platynereis* sp. 1 and 2, and *P. bicanaliculata* (Baird, 1863). n = individuals.

Species	*P.* sp. 1	*P.* sp. 2	*P. bicanaliculata*
P. sp. 1 (n=2)	0.005	0.211	0.258
P. sp. 2 (n=11)	0.211	0.011	0.181
P. bicanaliculata (n=3)	0.258	0.181	0.002

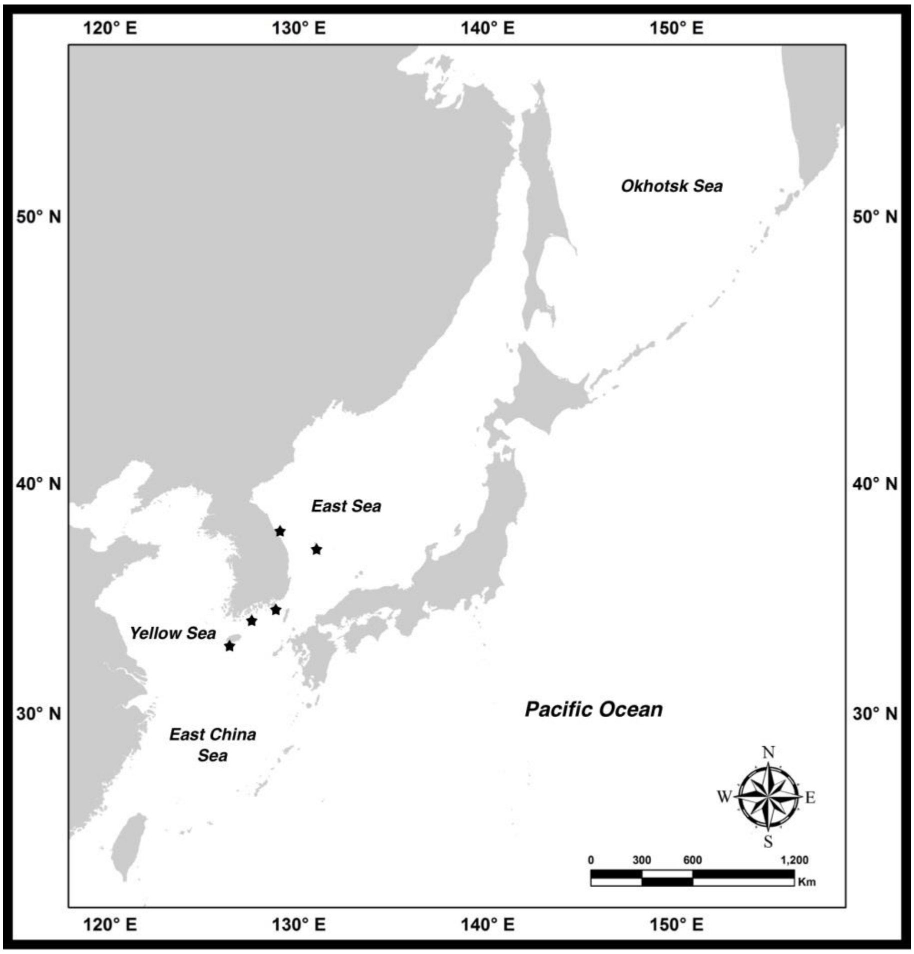

Fig. 95. Distribution of *Platynereis* sp. 2 in Northeast Asia based on the present study (★).

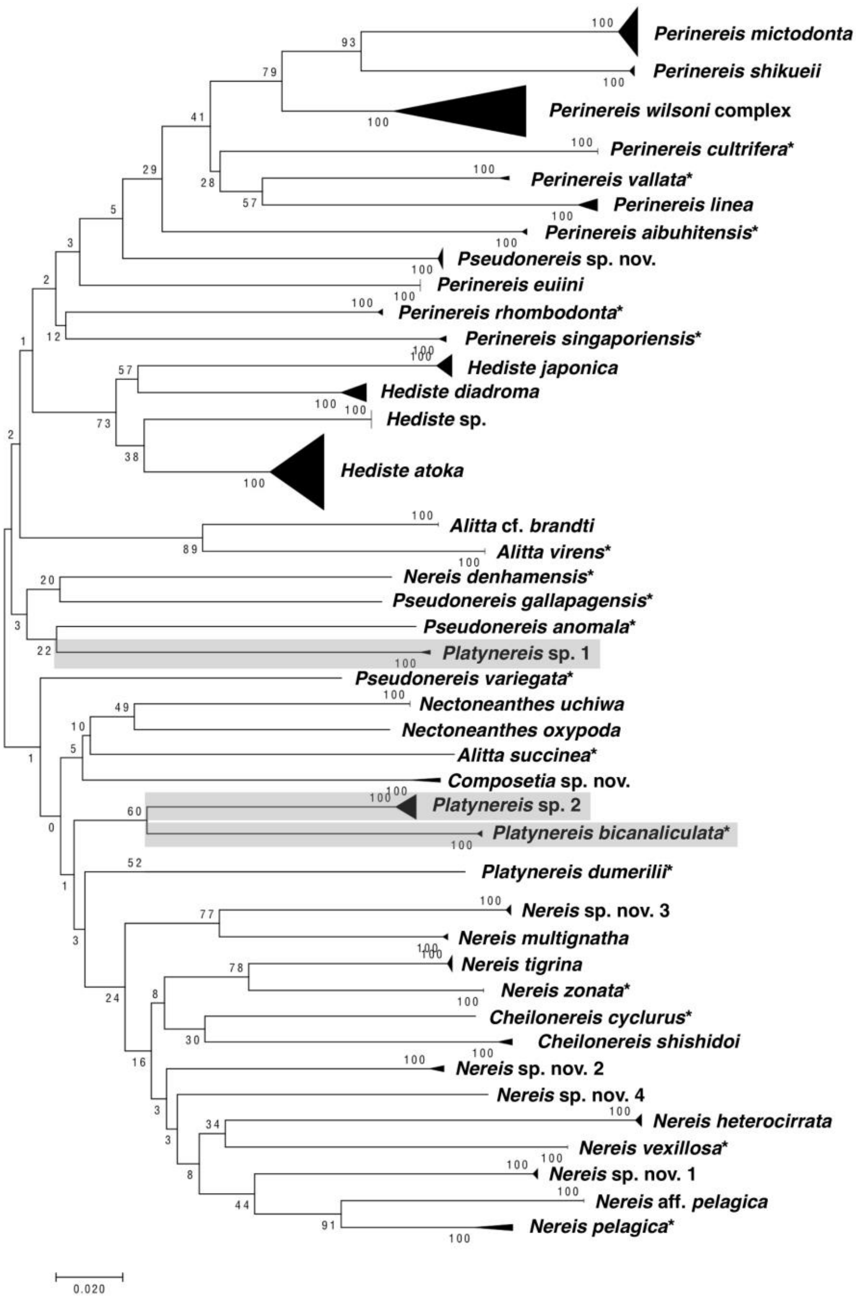

Fig. 96. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray boxes represent the difference among *Platynereis* sp. 1, *P*. sp. 2, and *P. bicanaliculata* (Baird, 1863). *Platynereis* sp. 1 and sp. 2: from Northeast Asia; *P. bicanaliculata*: from east north Pacific (Canada).

Genus *Pseudonereis* Kinberg, 1865

Pseudonereis Kinberg, 1865: 174.

Type species: *Pseudonereis gallapagensis* Kinberg, 1865.

Diagnosis

Prostomium with entire anterior margin, one pair of antennae, one pair of biarticulated palps with conical palpostyles, four pairs of tentacular cirri with distinct cirrophores. Two pairs of eyes. One apodous anterior segment, greater than length of chaetiger 1. Maxillary ring of pharynx with paragnaths, arranged in discrete areas, areas II–IV p-bars and conical paragnaths arranged in regular comb-like rows. Oral ring paragnaths present, area V conical paragnaths present or absent; area VI conical paragnaths present or absent, shield-shaped bars present or absent; area VII–VIII p-bars and conical paragnaths present. Dorsal notopodial ligule markedly elongate and markedly broader on posterior chaetigers. Prechaetal notopodial lobe present or absent. Dorsal cirrus terminally attached to dorsal notopodial ligule on posterior chaetigers (subterminally in *P. anomala*). Neuropodial superior lobe present (absent in *P. palpata* and *P. pseudonoodti*). Neuropodial postchaetal lobe absent or present, at least on some anterior chaetigers. Notoaciculae absent from chaetigers 1 and 2. Notochaetae homogomph spinigers present, homogomph falcigers present or absent. Neurochaetae, dorsal fascicle: heterogomph spinigers present or absent, homogomph spinigers present or absent, heterogomph falcigers present, blades serrated. Neurochaetae, ventral fascicle: heterogomph spinigers and heterogomph falcigers present (Bakken, 2007).

25. *Pseudonereis* sp. nov. (Figs. 97–100)

Pseudonereis formosa: Wu, 1967: 56–57.

Pseudonereis variegata: Imajima, 1972: 99–101, figs. 29a–m, 11; 1996: 137, fig. 109a–k; Paik, 1977: 170–171, fig. 15; 1982: 786, pl. 12G–I, 1984: 148; 1989: 306–307, pl. 23, fig. 61a(1, 2), b(1–3), text fig. 71A–H; Wu et al., 1985: 221–223, fig. 125A–J.

Materials examined

Type materials

Holotype, NIBRIV0000781334, associated with oysters in intertidal rocky shore, Donggo-ri, Sinji-myeon, Wando-gun, Jeollanam-do, Korea (34°20′3.39″N, 126°53′16.2″E), 9 October 2008, collected by Taeseo Park, fixed in 80% ethanol.

Non-type materials

NIBRIV0000783827, 1 ind., NIBRIV0000783851, 1 ind., associated with mussels in intertidal rocky shore, Seodori Port, Seodo-ri, Samsan-myeon, Yeosu-si, Jeollanam-do, Korea (34°3′20″N, 127°17′36″E), 24 April 2013, collected by Taeseo Park, Seul Yi, and Sang-Hwi Lee, fixed in 80% ethanol. NIBRIV0000783852, 1 ind., intertidal rocky shore, Yuksando Is., Songi-ri, Nagwol-myeon, Yeonggwang-gun, Jeollanam-do, Korea, 7 June 2007, collected by Taeseo Park, fixed in 70% ethanol. NIBRIV0000783710, 3 inds., associated with oysters in intertidal area, Bangjukpo Port, Jukpo-ri, Dolsan-eup, Yeosu-si, Jeollanam-do, Korea (34°37′49″N, 127°47′37″E), 17 March 2015, collected by Taeseo Park and Ye Eun, fixed in 80% ethanol. NIBRIV0000783708, 6 inds., Mangseok intertidal flat, Gunnae-ri, Wando-eup, Wando-gun, Jeollanam-do, Korea (34°18′6″N, 126°46′12″E), 4 September 2013, collected by Ye Eun and Seul Yi, fixed in 80% ethanol. NIBRIV0000783829, 1 ind., Wando-eup, Wando-gun, Jeollanam-do, Korea (34°20′23″N, 126°48′31″E), 5 September 2013, collected by Ye Eun and Seul Yi, fixed in 80% ethanol. NIBRIV0000783853, 1 ind., Donggo-ri, Sinji-myeon, Wando-gun, Jeollanam-do, Korea (34°20′3.39″N, 126°53′16.2″E), 9 October 2008, collected by Taeseo Park, fixed in 70% ethanol. NIBRIV0000783709, 3 inds., Biin Harbor, Maryangpo, Biin-myeon, Seocheon-gun, Chungcheongnam-do, Korea (36°8′10″N, 126°30′13″E), 30 March 2012, collected by Hyo-Jin Jeong and Dae-Eop Choi, fixed in 80% ethanol. NIBR0000783830, 1 ind., Sinpyeong-ri, Ilgwang-myeon, Gijang-gun, Busan-si, Korea (35°17′29″N, 129°15′46″E), 8 August 2006, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000783831, 7 inds., Dapo-ri, Nambu-myeon, Geoje-si, Gyeongsangnam-do, Korea (34°42′42.8″N, 128°35′15.8″E), 11 February 2009, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000783835, 13 inds., Ongnim-ri, Irun-myeon, Geoje-si, Gyeongsangnam-do, Korea (34°51′5″N, 128°43′11″E), 20 March 2012, collected by Taeseo Park and Jae-Young Kim, fixed in 80% ethanol. NIBRIV0000783855, 1 ind., Dapo-ri, Nambu-myeon, Geoje-si, Gyeongsangnam-do, Korea (34°42′42.8″N, 128°35′15.8″E), 11 February 2009, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000783834, 4 inds., Dochan-ri, Imja-myeon, Sinan-gun, Jeollanam-do, Korea (34°24′57.19″N, 127°54′16.37″E), 12 June 2012, collected by Hang-Pil Lee and Dae-Seong An, fixed in 80% ethanol. NIBRIV0000783854, 4 inds, intertidal rocky shore, Jindo-gun, Jeollanam-do, Korea, 8 October 2008, collected by Taeseo Park, fixed in 80% ethanol. NIBRIV0000783856, 3 inds., Cheongsando Is., Cheongsan-myeon, Wando-gun, Jeollanam-do, Korea (34°9′47″N, 126°52′18″E), 21 July 2012, collected by Hang-Pil Lee and Dae-Seong An, fixed in 80% ethanol. NIBRIV0000783858, 1 ind., mussel bed, Youngilman Harbor, Pohang-si, Cyeongsangbuk-do, Korea (36°4′5″N, 129°24′1″E), 28 February 2012, collected by Hang-Pil Lee, fixed in 80% ethanol. NIBRIV0000783857, 3 inds., intertidal area near Ulsan Harbor, Maeam-dong, Nam-gu, Ulsal-si, Korea (35°28′5″N, 129°22′27″E), 15 February 2012, collected by Pyung-Gang Lee, fixed in 80% ethanol. NIBRIV0000783832, 1 ind., NIBRIV0000783833, 1 ind., Oyster bed, Aburatsu Port, Nichinan, Miyazaki Prefecture, Japan, 18 November 2014, collected by T. Sakaguchi, fixed in 80% ethanol. NIBRIV0000787901, 1 ind., intertidal flat, Yung Shue Wan, Lamma Is., Hong Kong (22°13′36″N, 114°6′40″E), 15 March 2013, collected by Haejeong Kwon and Taeseo Park, fixed in 80% ethanol. USNM 35387, identified as *Pseudonereis formosa* Kinberg, 1866, 1 ind., King-Liaw, Taiwan, 12 March 1966, collected by Shi Kuei Wu. NSMT-Pol. 17207–17208, identified as *Pseudonereis variegata*, 1 ind., intertidal zone, Karasujima Is. near

Tamano, Okayama Prefecture, Japan (34°29.3′N, 133°58.2′E), May 1964, collected by Minoru Imajima.

Comparative materials

Non-types of *Pseudonereis gallapagensis* Kinberg, 1866 (USNM 35860), intertidal, Mancora, Peru, 13 June 1960, 2 of many inds., collected by W. L. Klawe.

Diagnosis

Brown pigmentation present on dorsum in live specimens. Single shield-shaped paragnath on each of area VI; single large conical paragnaths present in area I and V; area II–IV arranged in comb-like rows; lateral group of paragnaths absent in area III; large p-bar paragnaths present toward jaws in area IV. Notopodial dorsal ligules gradually and greatly expanded posteriorly. Notopodial prechaetal lobe and neuropodial postchaetal lobe absent.

Description of atokes

Holotype, complete with 121 chaetigers, 90 mm long, 2.7 mm and 4.2 mm wide excluding and including parapodia at chaetiger 10, respectively.

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Dorsum with stout pigmentation of brown color in live individuals, with pale pigmentation of brownish cream color in preserved ones.

Prostomium pyriform, slightly longer than wide, with pair of smooth, tapered antennae inserted at anterior end. Pair of palps with palpophores and shorter round palpostyles. Two pairs of eyes arranged trapezoidally; anterior pair slightly larger than posterior pair; gap of anterior pair slightly wider than posterior pair (Fig. 97A).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 3 in holotype (3–6 in other materials examined) (Fig. 97A).

Proboscis with pair of dark brown amber jaws, each with 7 teeth of serrated inner margin. Conical and p-bar paragnaths present on both maxillary and oral rings except area VI; single, shield-shaped paragnath on each side of area VI; paragnaths on oral ring larger than those on maxillary ring. Paragnath numbers and arrangements in holotype as follows (range in other material given in parentheses): area II–IV arranged in comb-like rows; area I, single large conical paragnath (1–2); area II with conical paragnath, 19 (11–31) on right and 20 (12–29) on left, arranged in triangular patch; area III with conical paragnath, 41 (26–45) in oval patch without lateral groups; area IV with p-bar and conical paragnaths, 58 (39–76) on right include 4 (0–5) large p-bars toward jaws and 60 (41–75) on left include 4 (2–5) large p–bars toward jaws, arranged in about 9–10 rows; area V, single large conical paragnath; area VI, single shield-shaped paragnath on each side; areas VII–VIII, 37 (28–47) conical and p-bar paragnaths in alternating arrangement in two irregular rows in central area (area VII) and single row in lateral sides (area VIII) (Figs. 97A–C, 98A; Table 56).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with reduced notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus (Fig. 97D, E).

Notopodia consisting of dorsal cirrus, dorsal ligule, and ventral ligule in biramous parapodia (Fig. 97D–K), notopodial prechaetal lobe and notoacicular process absent. Dorsal cirri slender, twice longer than notopodial ventral ligule throughout, basally attached in anterior chaetigers, sub-terminally attached in middle chaetigers (Fig. 97H, I), terminally attached to notopodial dorsal ligule in posterior chaetigers (Fig. 97J, K). Notopodial dorsal ligule short, obtusely rounded with blunt tip in anterior parapodia (Fig. 97F, G), gradually elongated in middle parapodia and greatly expanding up to four times length of notopodial ventral ligule in posterior parapodia (Fig. 97J, K). Notopodial ventral ligule oval with blunt tip in anterior and middle chaetigers, digitiform in posterior chaetigers (Fig. 97F–K).

Neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus throughout. Superior and inferior lobes present in neuropodial acicular lobe throughout (Fig. 97D–K). Neuropodial ventral ligule digitiform throughout, half length of neuropodial acicular lobe in anterior and middle chaetigers (Fig. 97F–I), similar in length to neuropodial acicular lobe in posterior chaetigers (Fig. 97J, K). Ventral cirri slender, similar in length to neuropodial acicular lobe throughout.

Notochaetae all homogomph spinigers; blades long with finely serrated edge. Upper neurochaetae consisting of heterogomph falcigers with serrated blades at anterior position, and homogomph spinigers (Fig. 97N) with long serrated blades at posterior position. Lower neurochaetae consisting of heterogomph falcigers (Fig. 97L) with serrated blades (Fig. 2L) at both anterior and posterior positions, and heterogomph spinigers (Fig. 97M) with long serrated blades (Fig. 2K) at superior posterior position. Heterogomph spinigers in lower acicular present from middle chaetigers.

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers in *Pseudonereis* sp. nov. are summarized in Table 56.

Habitats

Intertidal zones. Under stones in mudflats, rocky shores or associated with sessile organisms such as mussels and oysters.

Distribution

Type locality: Wando-gun, Jeollanam-do, Korea. East Asia (China, Taiwan, Korea, Japan) (Fig. 99).

Molecular data

The COI sequence data obtained from 10 individuals (Table 4, Appendix 2).

Remarks

Pseudonereis sp. nov. had been misidentified as *Pseudonereis variegata* (Grube, 1857) (type locality: Valparaiso, Chile) and *P. formosa* Kinberg, 1866 (type locality: Hawaii) from Northeast Asian waters (Wu, 1967; Imajima, 1972; 1996; Paik, 1977, 1989; Wu et al., 1985, see also synonymy). However, *Pseudonereis* sp. nov. is distinguishable from *P. variegata* by the following diagnostic characteristics: (1) having relatively stout paragnaths in both maxillary and oral rings (Fig. 98A), in contrast to those not stout in *P. variegata* (Fig. 98C), (2) paragnaths in area VII-VIII arranged in two transverse rows (Fig. 98A-2), in contrast to those arranged in only single row (Fig. 98C-2, Table 57).

Morphological characteristics of all specimens previously reported as *P. variegata* from Northeast Asian waters agreed well with those of *P*. sp. nov. (Table 56). Thus, it is concluded that they all belong to *P*. sp. nov. This conclusion is supported by comparison of DNA sequences of COI between *P*. sp. nov., and *P. variegata* from Chile (type locality). DNA sequences of specimen from Chile markedly differed from those of *P*. sp. nov. (mean p-distance: 0.228) (Fig. 100, Table 55), indicating that Chilean specimens belonged to *P. variegata sensu stricto*, whereas specimens from Northeast Asia belonged to *P*. sp. nov., not *P. variegata*.

Wu (1967) reported *P. formosa* from Taiwan which was synonymized with *P. gallapagensis* by Hartman (1948). In the present study, probable material of Wu (1967) which has been housed in Smithsonian Institution, National Museum of Natural History, was examined, confirming that diagnostic characteristics of *P. formosa sensu* Wu, 1967 agreed well with those of *P.* sp. nov. (Fig. 98B, Table 56). Therefore, *P. formosa sensu* Wu, 1967 belong to *P.* sp. nov., not *P. galapagensis*.

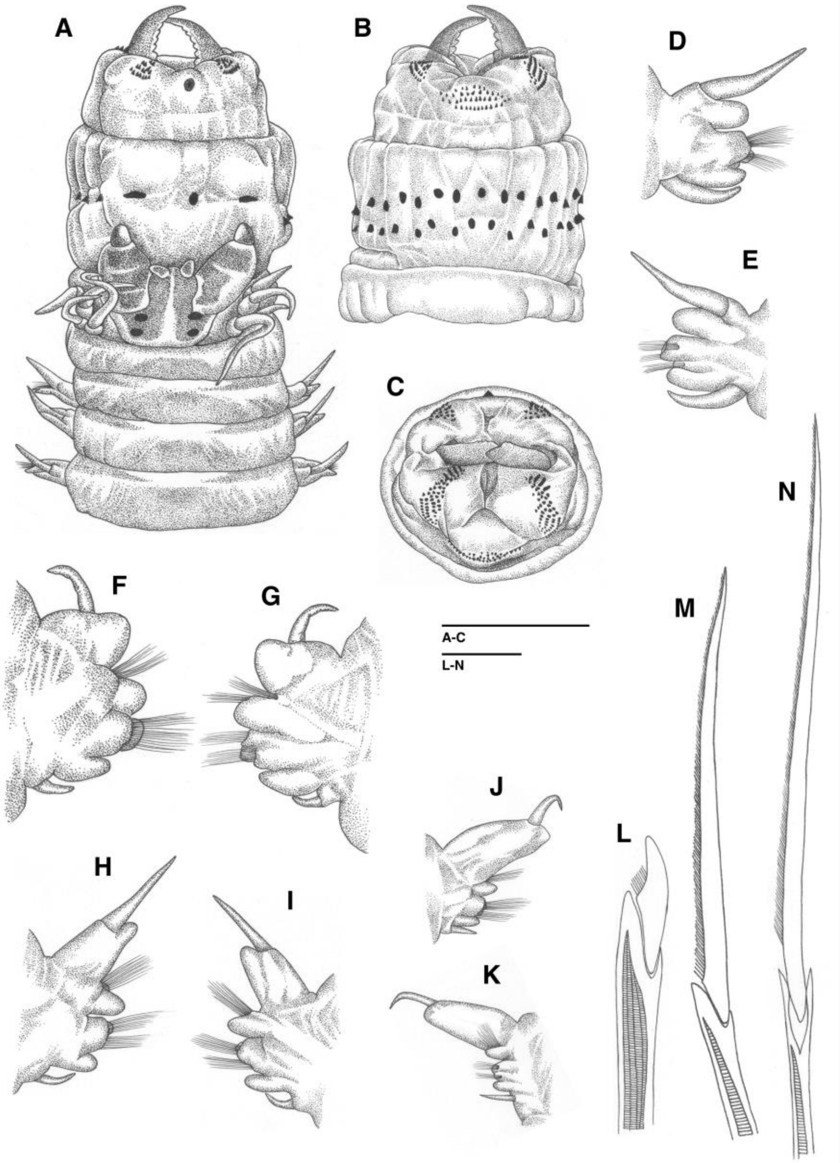

Fig. 97. *Pseudonereis* sp. nov., holotype, NIBRIV0000781334. (A–C) Dorsal, ventral, and frontal views of anterior end with the everted proboscis. (D–K) Anterior and posterior views of parapodium 1 (D, E); 10 (F, G, anterior); 60 (H, I, middle); 94 (J, K, posterior). (L) Heterogomph falciger from lower neurochaetae in parapodium 60. (M) Heterogomph spiniger from lower neurochaetae in parapodium 10. (N) Homogomph spiniger from upper neurochaetae in parapodium 60. Scale bars: 2 mm in (A–C); 0.03 mm in (L–N).

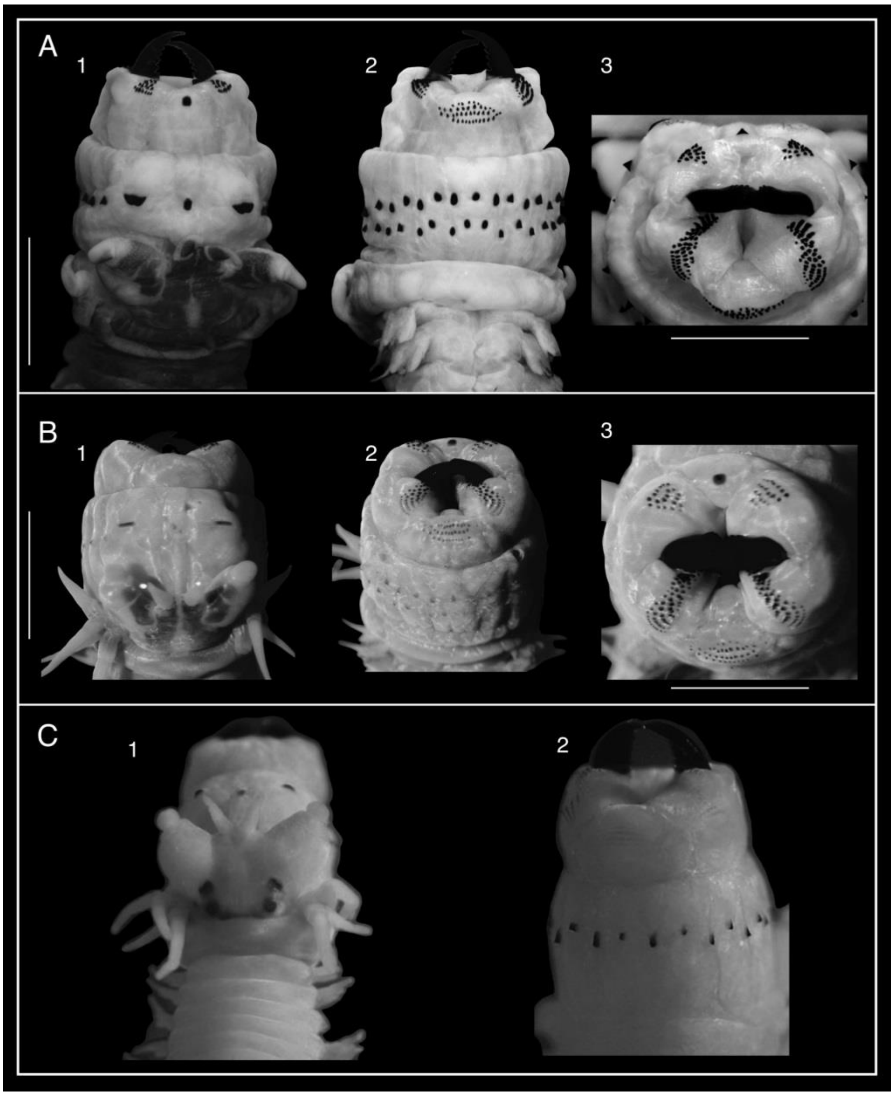

Fig. 98. Dorsal, ventral, and frontal views of everted proboscis of *Pseudonereis* sp. nov. and *Pseudonereis variegata* (Grube, 1857). (A, B) *P.* sp. nov.: (A) holotype (NIBRIV0000781334), (1) dorsla view, (2) ventral view, and (3) frontal view. (B) *P. formosa sensu* Wu, 1967 (USNM 35387), (1) dorsla view, (2) ventral view, and (3) frontal view. (C) *P. variegata*, syntype of *Nereis felox* Hansen, 1882 (ZMUB 2130) (modified from Bakken, 2007), (1) dorsal view, and (2) ventral view. Scale bars: 2 mm.

Table 55. Mean pairwise genetic distances (K2P distance) based on COI sequences between *Pseudonereis* sp. nov. 1 and *P. variegata* (Grube, 1857). n = individuals.

Species	*P.* sp. nov. 1	*P. variegata*
P. sp. nov. 1 (n=3)	0.002	0.228
P. variegata (n=1)	0.228	-

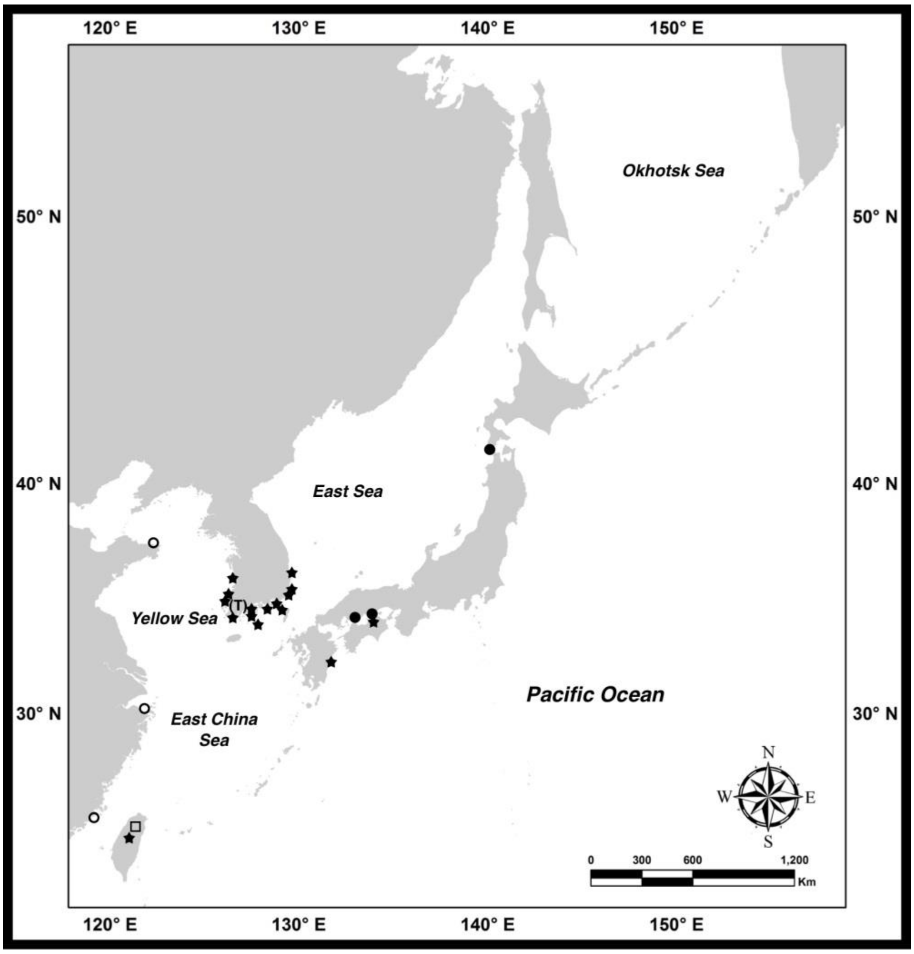

Fig. 99. Distribution of *Pseudonereis* sp. nov. in Northeast Asia based on the present study (★) and literature. (□) Wu (1967), (●) Imajima (1972), (○) Wu et al. (1985). (T) Type locality.

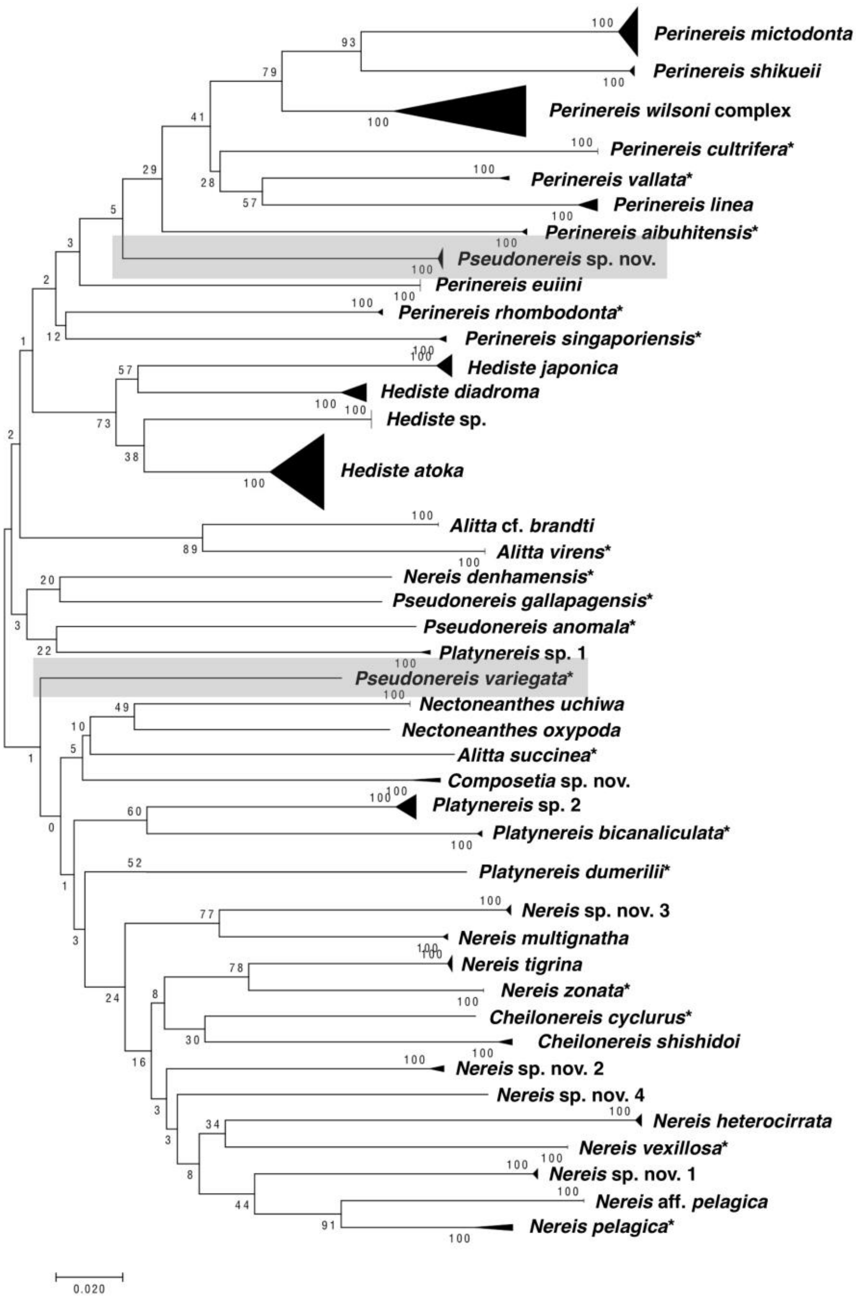

Fig. 100. Neighbor joining tree (Kimura 2-parameter model) of 42 nereidid species based on COI sequences. Asterisks (*) indicate comparative taxon. Gray boxes represent the difference between *Pseudonereis* sp. nov. and *P. variegata* (Grube, 1857).

Table 56. Variation in paragnath numbers in area I to VIII on proboscis of *Pseudonereis* sp. nov. Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Locality	**I**	**II(L)**	**II(R)**	**III**	**IV(L)**	**IV(R)**	**V**	**VI(L)**	**VI(R)**	**VII–VIII**
Korea (n=55) (Present study)	1–2 (1±0.1)	12–29 (19.9±3.8)	11–31 (20±3.8)	26–45 (34.2±4.4)	41–75 (54.1±6.9)	39–76 (54.1±6.9)	1	0–2 (1±0.2)	0–2 (1±0.2)	28–49 (38.6±3.1)
Korea (n=?) (Paik, 1977 as *P. variegata*)	1	15	15	30	45–50		1	1	1	40
Japan (n=3) (Present study)	1	15–24 (18.3±4.9)	15–25 (18.7±5.5)	33–37 (34.7±2.1)	46–49 (47.3±1.5)	45–55 (49.3±5.1)	1	1	1	37–38 (37.7±0.6)
Japan (n=?) (Imajima, 1972 as *P. variegata*)	1	16		33	46–49		1	1	1	38
Hong Kong (n=1) (Present study)	1	16	16	28	46	45	1	1	1	37
China (n=?) (Wu et al., 1985 as *P. variegata*)	1	16–20		24–30	36–48		1	1	1	3–4 irregular rows
Taiwan (n=1) (Present study)	1	22	20	39	60	59	1	1	1	35
Taiwan (n=1) (Wu, 1967 as *P. formosa*)	1	3–4		3 pectinated rows	pectinated rows and an apical group of cones		1	1	1	2 rows

Table 57. Comparison of key characteristics and distributions of *Pseudonereis* sp. nov. and *P. variegata* (Grube, 1857).

Species (Locality and reference)	**Range of paragnath number**							**Neuropodial postchaetal lobe**	**Type locality (distribution)**
	I	**II***	**III**	**IV***	**V**	**VI***	**VII–VII**		
P. sp. nov. (Korea, present study, 55 type and non-types)	1–2	11–31	26–45	39–76	1	0–2 (usually 1)	28–49 (two rows)	present	Korea (Northeast Asia)
P. variegata (Rio de Janeiro, Bakken 2007, syntypes of *Nereis ferox* Hansen, 1882)	1–2	13–14	59–76	63–87	1	1	18–21 (single row)	present	Valparaiso, Chile (Atlantic Ocean)

*Paragnath numbers on each side.

26. *Pseudonereis* aff. *anomala* Gravier, 1901 (Figs. 101–104)

Nereis nichollsi: Imajima, 1972: 112–124, figs. 39a–p, 40a–c, 51; 1996: 150–151, figs. 119a–k, 119'a–f; Paik, 1977: 180–181, fig. 19A–F; 1982: 787, pl. 13a–c; 1989: 322–323; Wu et al., 1985: 101–103, fig. 54A–J.

Materials examined

Non-type materials

NIBRIV0000787947, 2 inds.; NIBRIV0000783844, 1 ind., Western coast (Yellow sea) of South Korea, no further data, fixed in formalin. NIBRIV0000783818, 1 ind., subtidal rocky area, Bumseom islet, Beophwan-dong, Seogwipo-si, Jeju-do, Korea (33°13′94″N, 126°30′48.6″E), 17 May 2012, collected by Taeseo Park, fixed in formalin. NSMT-Pol.78346, 1 ind., collected and identified by Minoru Imajima, no further data. NSMT-Pol.17224–17226, 1 ind. of many, Amakusa, Kumamoto Prefecture, Japan (32°31.4′N, 130°02.2′E), Octber 1963, collected and identified by Minoru Imajima.

Diagnosis

Conical paragnaths present on each of area VI; paragnath absent on area V; area II–IV with p-bar paragnaths arranged in comb-like rows; lateral group of paragnaths absent in area III; Notopodial dorsal ligules gradually and greatly expanded posteriorly. Notopodial homogomph or sesquigomph falcigers present on middle and posterior parapodia. Notopodial prechaetal and neuropodial postchaetal lobes absent.

Description of atokes

Body gradually tapered posteriorly toward pygidium. Dorsum convex, venter relatively flat with longitudinal midventral groove. Colour in preserved specimens pale brown.

Prostomium pyriform, longer than wide, with pair of thick, tapered antennae inserted at anterior end. Pair of palps with massive palpophores and thick globose palpostyles. Two pairs of eyes arranged trapezoidally; gap of anterior pair wider than posterior pair (Fig. 102A).

Peristomium longer than other chaetigers, with four pairs of tentacular cirri; posterior dorsal tentacular cirri longest, reaching back to chaetiger 3–4 (Fig. 102A).

Proboscis with pair of dark brown amber jaws, each with 5–6 teeth of serrated inner margin. Conical and p-bar paragnaths present on both maxillary and oral rings. Paragnath numbers and arrangements as follows: area II–IV arranged in comb-like rows; area I, 1–2 large conical paragnaths; area II with p-bar paragnaths, 13–20 on left and 12–21 on right in 4 rows; area III, 20–43 p-bar paragnaths in 4 rows without lateral groups; area IV with p-bar paragnaths and additional conical paragnaths toward jaw, 26–34 on left and 22–32 on right arranged in 5–6 rows; area V, absent; area VI with conical paragnaths, 5–12 on left and 5–13 on right in transverse row; areas VII–VIII, 8–16 conical and p-bar paragnaths in alternating arrangement in single row (Figs. 101A, 102A–C; Table 58).

Parapodia of first two chaetigers sub-biramous, all following posterior parapodia biramous. Sub-biramous parapodia without notoacicula and with reduced notopodia consisting of dorsal cirrus and dorsal ligule, and with neuroacicula and neuropodia consisting of acicular lobe, ventral ligule, and ventral cirrus (Fig. 102D).

Notopodia consisting of dorsal cirrus, dorsal ligule, and ventral ligule in biramous parapodia (Fig. 102D–G), notopodial prechaetal lobe and notoacicular papilla absent. Dorsal cirri thick, more than three times longer than notopodial ventral ligule in anterior parapodia (Fig. 102E), twice as long as notopodial ventral ligule in middle and posterior parapodia (Fig. 102F, G); basally attached in anterior parapodia (Fig. E), sub-terminally attached in middle and posterior parapodia (Fig. 102F, G). Notopodial dorsal ligule short, obtusely rounded with blunt tip in anterior parapodia, gradually elongated in middle parapodia and greatly expanding up to three times length of notopodial ventral ligule in posterior parapodia (Fig. 102E–G). Notopodial ventral ligule thick, cylindrical with round tip, subequal to notopodial dorsal ligule in anterior parapodia; subconical with bluntly tapered tip in middle and posterior parapodia (Fig. 102E–G).

Neuropodia consisting of acicular ligule, ventral ligule, and ventral cirrus throughout. Superior and inferior lobes present in neuropodial acicular lobe in anterior and middle parapodia (Fig. 102E, F). Neuropodial ventral ligule digitiform throughout, half length of neuropodial acicular ligule in anterior and middle chaetigers (Fig. 102E, F), similar in length to neuropodial acicular ligule in posterior chaetigers (Fig. 102G). Ventral cirri thick, similar in length to neuropodial ventral ligule throughout.

Notopodial homogomph spinigers and falcigers present (Fig. H, J), homogomph falcigers serrated. Upper neurochaetae consisting of heterogomph falcigers (Fig. 102M) with serrated blades, and homogomph or sesquigomph spinigers (Fig. 102K, L) with long serrated blades. Lower neurochaetae consisting of heterogomph falcigers with serrated blades (Fig. 102I) and, heterogomph spinigers with long serrated blades (Fig. 102N). Heterogomph spinigers in lower acicular present from middle parapodia.

Pygidium with anus on dorsal side, with pair of tapering cylindrical anal cirri.

Variation in paragnath number

Paragnath numbers in *Pseudonereis* aff. *anomala* are summarized in Table 58.

Habitats

Rocky shore of intertidal and subtidal zones associated with sessile organisms.

Distribution

China, Japan, Korea (Fig. 104).

Remarks

The present specimens from Northeast Asia are similar to *P. anomala* redescribed by

Bakken (2007) based on general morphology (Fig. 101). Recently, Glasby et al. (2013) have recognized that *P. anomala* comprises two cryptic species by DNA sequence comparisons of COI and histone H3. They described one new species of *P. anomalopsis* which could be distinguished from *P. anomala* baed on the number and arrangement of paragnaths on the proboscis (Fig. 103). They also referred one unnamed species which could not be distinguished from *P. anomala* by morphology. Although the present specimens are similar to *P. anomala* in morphology, further DNA sequence comparison is needed to confirm their taxonomic status.

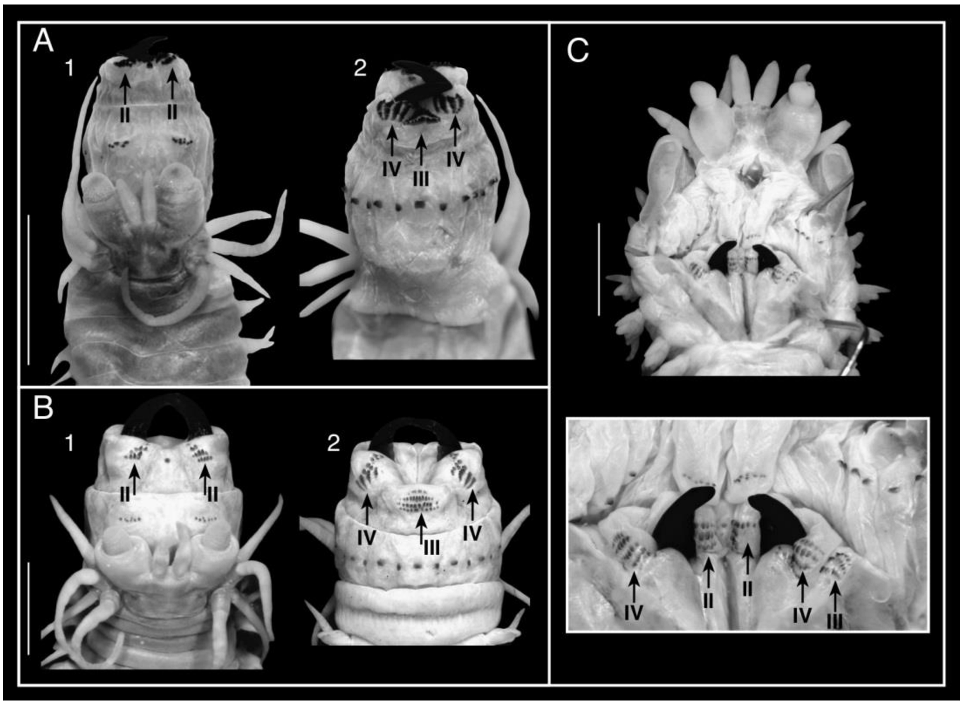

Fig. 101. Dorsal and ventral views of everted proboscis of *Pseudonereis* aff. *anomala* Gravier, 1901. (A) *P.* cf. *anomala* (NIBRIV0000783818), (1) dorsal view, and (2) ventral view. Arrows indicate comb-like rows paragnaths on maxillary ring. (B, C) Japanese specimens previously identified as *Nereis nichollsi* Kott, 1951: (B) (NSMT-Pol-17224–17226), (1) dorsal view, (2) and ventral view; (C) (NSMT-Pol-78346). Arrows indicate comb-like rows paragnaths on maxillary ring. Scale bars: 2 mm.

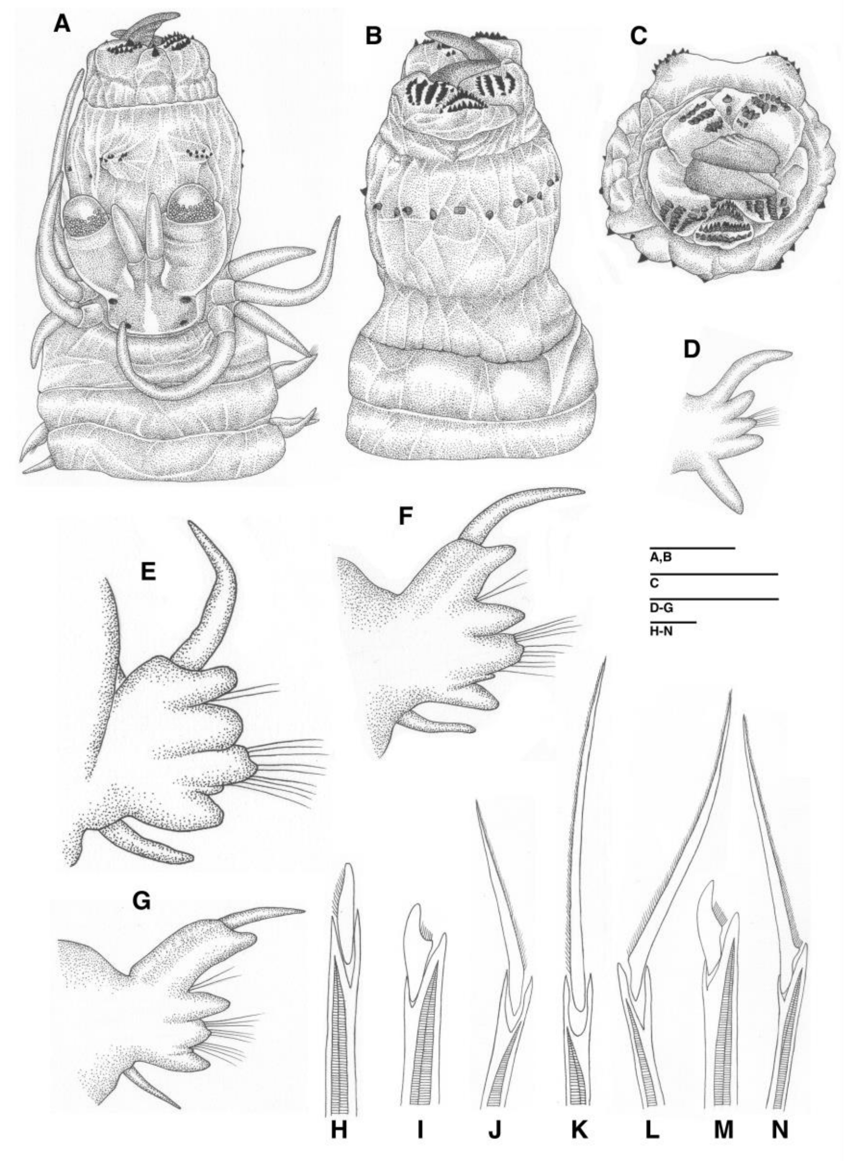

Fig. 102. *Pseudonereis* aff. *anomala* Gravier, 1901, NIBRIV0000783818. (A–C) Dorsal, ventral, and frontal views of anterior end with the everted proboscis. (D–G) Anterior views of parapodium 1 (D); 7 (F); 30 (E); 50 (G). (H) Homogomph falciger from notochaetae in posterior parapodium. (I) Heterogomph falciger from lower neurochaetae in parapodium 11. (J) Homogomph spiniger from notochaetae in parapodium 30. (K) Homogomph spiniger from upper neurochaetae in parapodium 30. (L) Sesquigomph spiniger from upper neurochaetae in parapodium 6. (M) Heterogomph falciger from upper neurochaetae in parapodium 11. (N) Heterogomph spiniger from lower neurochaetae in parapodium 30. Scale bars: 1 mm in (A–G); 0.02 mm in (H–N).

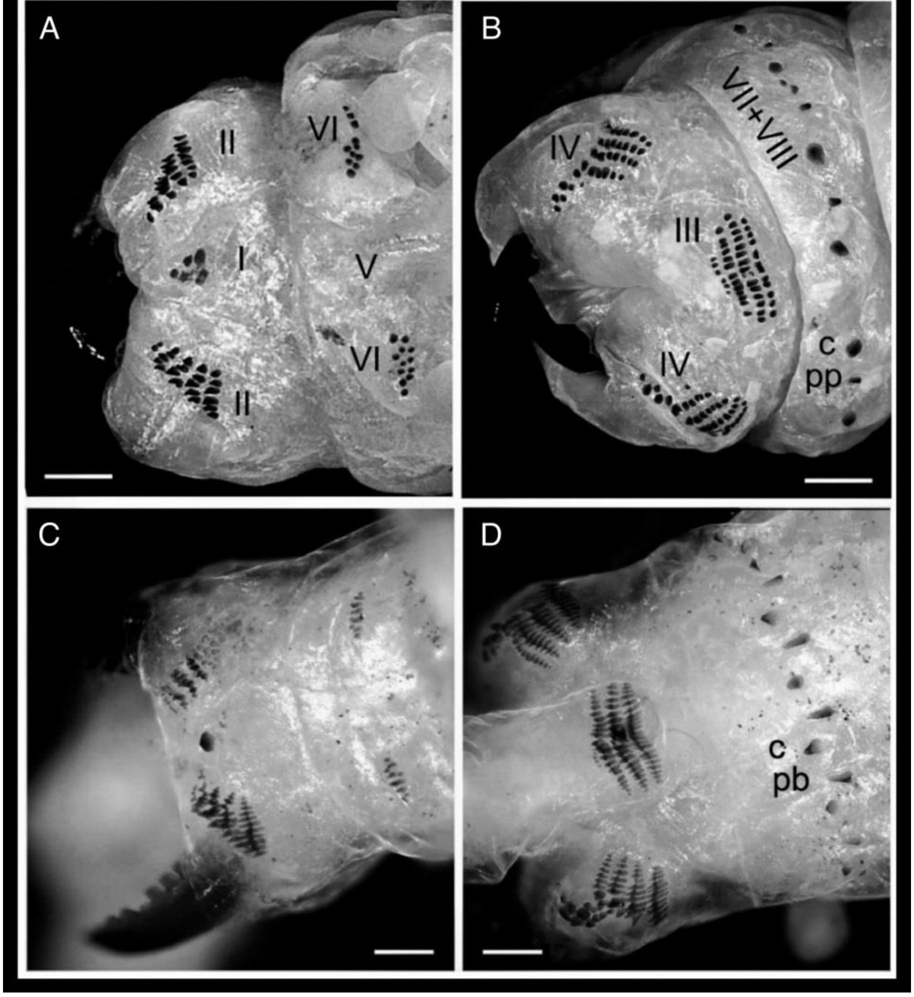

Fig. 103. Dorsal and ventral views of everted proboscis of *Pseudonereis anomala* Gravier, 1901 and *P. anomalopsis* Glasby, Wei and Gibb, 2013 (modified from Glasby et al, 2013). (A, B) *P. anomala* (NTM W17343). (C, D) *P. anomalopsis* (NTM W22616). Scale bars: 0.5 mm in (A, B); 0.2 mm in (C, D).

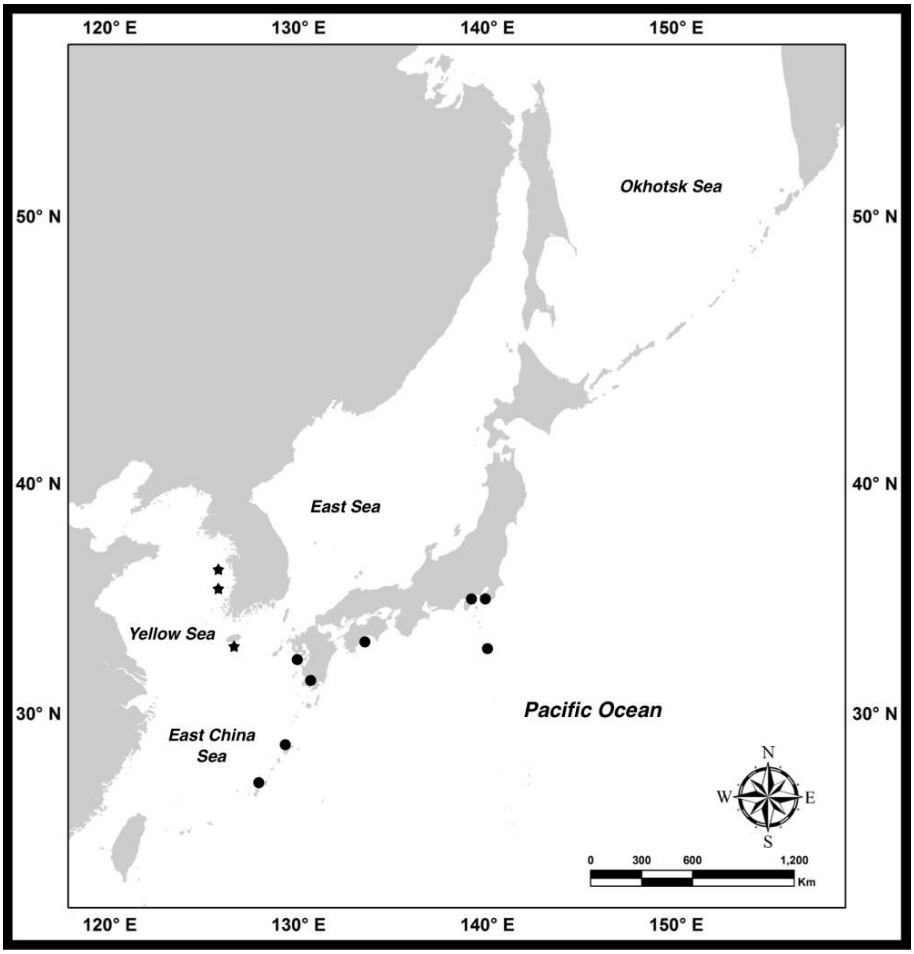

Fig. 104. Distribution of *Pseudonereis* aff. *anomala* Gravier, 1901 in Northeast Asia based on the present study (★) and literature. (●) Imajima (1972).

Table 58. Variation in paragnath numbers in area I to VIII on proboscis of *Pseudonereis* aff. *anomala* Gravier, 1901. Ranges (mean ± standard deviation) are shown. n: number of individual, L: left side, R: right side.

Locality (Reference)	**I**	**II(L)**	**II(R)**	**III**	**IV(L)**	**IV(R)**	**V**	**VI(L)**	**VI(R)**	**VII–VIII**
Pseudonereis aff. *anomala*										
Korea (n=4) (Present study)	1–2 (1.8±0.5)	13–20 (17.3±3.1)	12–21 (16.5±4.7)	20–40 (33.8±10.9)	26–34 (29.8±3.3)	22–32 (28.5±4.5)	none	5–12 (7.8±3)	5–13 (8.5±3.4)	8–16 (12.5±3.3)
Korea (n=?) (Paik, 1977 as *N. nichollsii*)	1	15		40	35		none	7		15
Japan (n=1) (Present study, NSMT-Pol.17224–17226, as *N. nichollsii*)	1	12	15	42	32	33	none	7	7	15
Japan (n=?) (Imajima, 1972 as *N. nichollsii*)	1	13–15		41	34		none	7		15
China (n=?) (Wu et al., 1985 as *N. nichollsii*)	2	14–26		4 rows, each row 9–16	upper 2 rows, each 3–4 lower 5 rows, each 9–16		none	2 rows, each 4–8		2 rows, each 15–17
Pseudonereis anomala										
(Bakken, 2007)	1–3	11–31		30–72	20–52		none	3–15		10–24

Conclusion

Conclusion

A taxonomic study on nereidid species from Northeast Asian waters was conducted. For the first step of this study, a total of 105 nominal species were compiled based on literatures and 53 nominal species originally reported from different areas not belonging to this marine biogeographic region were recognized. Of these, 27 nominal species were selected (Table 59) and reexamined using molecular and morphological analyses based on type and non-type specimens.

In Chapter 1, molecular taxonomic study using a 'reverse taxonomic' approach was applied based on COI sequences. A total of 32 nereidid species (22 species among 27 selected species; 22 comparative species; 10 were overlapped species) were analyzed. This analysis revealed the likely presence of undescribed or misidentified species among previously reported nereidids (*Perinereis wilsoni*, *P. cultrifera*, *Pseudonereis variegata*, *Hediste japonica*, *Nereis denhamensis*, *N. vexillosa*, *N. pelagica*, *N. multignatha*, *Platynereis bicanaliculata*, and *Cheilonereis cyclurus*) from Northeast Asian waters. Of these, type locality of three species (i.e., *Perinereis wilsoni*, *Hediste japonica*, and *N. multignatha*) is Northeast Asia. Each of them was composed of cryptic species. Other seven species (i.e., *Perinereis cultrifera*, *Pseudonereis variegata*, *Platynereis bicanaliculata*, *Cheilonereis cyclurus*, *Nereis denhamensis*, *N. vexillosa*, and *N. pelagica*) were originally described from areas outside of Northeast Asia. They were represented by different clades based on comparison of COI sequences from their type locality (or close to type locality).

In Chapter 2, taxonomic revision of 27 selected nominal species of Northeast Asian nereidids were conducted by comparison with type and non-type specimens or recent redescriptions and COI DNA sequences. Two unknown species were collected from Korean waters during field survey for this study. They were described as new species: *Nereis* sp. nov 2 and *Composetia* sp. nov.

Taxonomic revision is summarized as follows (also see Table 59).

Table 59. Emended taxonomic ststus of 27 selected nominal species among 105 nominal species previously reported from Northeast Asian waters.

No.	Genus	Selected nominal species	Emended taxonomic status
	Alitta		
1		*A. brandti* Malmgren, 1865	1. *A.* cf. *brandti* Malmgren, 1865
	Cheilonereis		
2		*C. cyclurus* (Harrington, 1897)	2. *C. shishidoi* (Izuka, 1912), reinst., n. comb.
	Hediste		
3		*H. atoka* Sato and Nakashima, 2003	3. valid
4		*H. diadroma* Sato and Nakashima, 2003	4. valid, new to Korean waters
5		*H. japonica* (Izuka, 1908)	5. valid
			6. *H.* sp., cryptic species determined
	Nectoneanthes		
6		*N. oxypoda* (Marenzeller, 1879)	7. valid
7		*N. uchiwa* Sato, 2013	8. valid
	Nereis		
8		*N. denhamensis* Augener, 1913	9. *N.* sp. nov. 1
9		*N. heterocirrata* Treadwell, 1931	10. valid
10		*N. multignatha* Imajima and Hartman, 1964	11. valid
			12. *N.* sp. nov. 3
11		*N. neoneanthes* Hartman, 1948	11. *N. multignatha* Imajima and Hartman, 1964
12		*N.* (*Neanthes*) *orientalis* Treadwell, 1936	13. *P. linea*, syn. nov.
13		*N. pelagica* Linnaeus, 1758	14. *N.* aff. *pelagica*
14		*N. tigrina* Zachs, 1933	15. valid, new to Korean waters
15		*N. vexillosa sensu* Imajima, 1972	16. *N.* sp. nov. 4
	Perinereis		
16		*P. aibuhitensis* (Grube, 1878)	13. *P. linea* (Treadwell, 1936)
17		*P. cultrifera* (Grube, 1840)	17. *P. euiini* Park & Kim, 2017
18		*P. floridana* (Ehlers, 1868)	17. *P. euiini* Park & Kim, 2017
19		*P. linea* (Treadwell, 1936)	13. valid
20		*P. mictodonta* (Marenzeller, 1878)	18. valid
21		*P. shikueii* Glasby and Hsieh, 2006	19. valid, new to Korean waters
22		*P. vancaurica tetradentata* Imajima, 1972	13. *P. linea*, syn. nov.
23		*P. wilsoni* Glasby and Hsieh, 2006	20. *P. wilsoni* species complex
	Platynereis		
24		*P. bicanaliculata* (Baird, 1863)	21. *P.* sp. 1
			22. *P.* sp. 2
	Pseudonereis		
25		*P. anomala* Gravier, 1901	23. *P.* aff. *anomala*
26		*P. formosa* Kinberg, 1866	24. *P.* sp. nov.
27		*P. variegata* (Grube, 1857)	24. *P.* sp. nov.
			25. *Composetia* sp. nov.
			26. *Nereis* sp. nov. 2

1. Present taxonomic status of 9 nominal species (*Hediste atoka*, *H. diadroma*, *Nectoneanthes oxypoda*, *N. uchiwa*, *N. heterocirrata*, *N. tigrina*, *P. linea*, *P. mictodonta*, and *P. shikueii*) are confirmed by COI sequence comparison;

2. Cryptic species are determined from four species (*Hediste japonica*, *Nereis multignatha*, *Perinereis wilsoni*, and *Platynereis bicanaliculata*);

3. Seven species (*Perinereis floridana*, *P. cultrifera*, *Nereis denhamensis*, *N. pelagica*, *N. vexillosa*, *N. neoneanthes*, and *Pseudonereis variegata*) have been misidentified. *Perinereis floridana* and *P. cultrifera* turned out to be *P. euiini*, *Nereis denhamensis* and *N. vexillosa* turned out to be *N.* sp. nov. 1 and *N.* sp. nov. 4, respectively. *Pseudonereis variegata* turned out to be a new species. *Nereis neoneanthes* is newly identified as *N. multignatha*. *Nereis pelagica* turned out to be undescribed species. However, further study is needed to describe it as a new species;

4. *Cheilonereis cyclurus* differs from its type specimen. *Nereis shishidoi* is reinstated and transferred to genus *Cheilonereis* which was a junior synonym of *C. cyclurus* based on molecular and comparison of type specimens;

5. Two nominal species *Nereis* (*Neanthes*) *orientalis* and *Perinereis vancaurica tetradentata* are newly synonymized to *P. linea* based on their type specimens;

6. *Alitta brandti* and *Pseudonereis anomala* turned out to be unknown species. However, further taxonomic review is needed to confirm their taxonomic status;

7. Three species (*Hediste didroma*, *Nereis tigrina*, and *Perinereis shikueii*) are newly reported from Korean waters.

At present, 105 nominal nereidid species have been reported from Northeast Asian waters. Although some of these are uncertain, 80 species of these might be valid, including results of the present study (Table 60). Among these, 51 species are originally described from this marine biogeographic region.

Table 60. A list of 105 nominal nereidid species and subspecies from Northeast Asian waters and their current status. The results from this study are included.

Subfamily genus	Nominal species (Type locality)	Current status	References
Namanereidinae			
Lycastis	1. *L. longicirris* Takahashi, 1933; (Taiwan)	*Namalycastis longicirris* (Takahashi, 1933)	Hartman (1959)
Lycastopsis	2. *L. augeneri* Okuda, 1937; Imajima, 1972; Paik, 1977; Wu et al., 1985; (Japan)	*Namanereis littoralis* (Grube, 1871) species group	Glasby (1999)
Namalycastis	3. *N. hawaiiensis* (Johnson, 1903); Sato, 2017; (Hawaii)	valid	Sato (2017)
	4. *N. indica* (Southern, 1921); Wu, 1967; (Mozambique)	valid	Wu (1967)
Gymnonereidinae			
Ceratocephale	5. *C. borealis* Wesenberg-Lund, 1950; Imajima, 2009; (Japan)	valid	Imajima (2009)
	6. *C. osawai* Izuka, 1903; (Japan)	*Tylorrhynchus heterochaetus* (Quatrefages, 1866)	Hartman (1959), Imajima (1972)
	7. *C. sibogae* (Horst, 1918) *sensu* Khlebovich & Wu, 1962; (Indonesia)	*Tambalagamia fauveli* Pillai, 1961	Wu et al. (1985)
Tambalagamia	8. *T. fauveli* Pillai, 1961; Imajima 1972; Wu et al., 1985; Paik, 1982; (Sri Lanka)	valid	Sato (2017)
Nereidinae			
Ceratonereis	9. *C. burmensis* Monro, 1937; Wu, 1967; Uchida, 1990; (Myanmar)	*Neanthes glandicincta* (Southern, 1921)	Lee & Glasby (2015)
	10. *C. erythraeensis* Fauvel, 1918; Imajima, 1972; Wu et al., 1985; Paik, 1977; (Percian Gulf)	*Simplisetia erythraeensis* (Fauvel, 1918)	Hartmann-Schröder (1985)
	11. *C. hircinicola* (Eisig, 1870); Imajima, 1972; Wu et al., 1985; Paik, 1982; (Mediterranean Sea)	*Composetia hircinicola* (Eisig, 1870)	Hartman (1938)
	12. *C. japonica* Imajima, 1972; (Japan)	valid	Imajima (1972), Sato (2017)
	13. *C. mirabilis* Kingberg, 1866; Imajima, 1972; (Brazil)	valid	Imajima (1972), Sato (2017)
	14. *C. moorei* Imajima, 1972; (Japan)	*Composetia moorei* (Imajima, 1972)	Hartmann-Schröder (1985)
	15. *C. pachychaeta* Fauvel, 1918; Imajima, 1972; Wu et al., 1985; (Madagascar)	*Neanthes pachychaeta* (Fauvel, 1918)	Glasby et al. (2011)
Cheilonereis	16. *C. cyclurus* (Harrington) *sensu* Okuda, 1950; Imajima, 1972; Wu et al., 1985; Paik, 1977; Khlebovich, 1996; Sato, 2017; (Puget Sound)	*C. shishidoi* (Izuka, 1912) reinstatement, n. comb.	present study

Table 60. Continued.

Subfamily genus	Nominal species	Current status	References
Hediste	*17. H. atoka* Sato & Nakashima, 2003; (Japan)	valid	Sato & Nakashima (2003), present study
	18. H. diadroma Sato & Nakashima, 2003; (Japan)	valid; new to Korean waters	Sato & Nakashima (2003), present study
Leonnates	*19. L. nipponicus* Imajima, 1972; (Japan)	valid	Imajima (1972), Salazar-Vallejo et al. (2014), Sato (2017)
	20. L. persicus Wesenberg-Lund, 1949; (Persian Gulf)	valid	Sato & Kubo (2009), Sato (2017)
Neanthes	*21. N. caudata* (Delle Chiaje, 1822) *sensu* Imajima, 1972; Paik, 1977; (?)	*Neanthes acuminata* (Ehlers, 1868)	Reish et al. (2014).
	22. N. diversicolor sensu Marenzeller, 1879; Imajima & Hartman, 1964; (Norway)	? *H. japonica* (Izuka, 1908)	from synonymy
	23. N. donghaiensis Wu, Sun & Yang, 1981; (China)	valid	Wu et al. (1985), Salazar-Vallejo et al. (2014)
	24. N. flava Wu, Sun & Yang, 1981; (China)	valid	Wu et al. (1985)
	25. N. glandicincta (Southern, 1921); Wu, 1967; (Indo)	valid	Wu (1967)
	26. N. succinea (Leuckart, 1847); Imajima, 1972; Paik, 1977; (Germany)	valid	Sato (2013, 2017)
Nectoneanthes	*27. N. latipoda* Paik, 1973; (Korea)	*N. oxypoda* (Marenzeller, 1879)	Sato (2013, 2017)
	28. N. multignatha Wu, Sun & Yang, 1981; (China)	*N. oxypoda* (Marenzeller, 1879)	Sato (2013, 2017)
	29. N. uchiwa Sato, 2013; (Japan)	valid	Sato (2013, 2017), present study
Nereis	*30. N.* (*Alitta*) *oxypoda* Marenzeller, 1879; (Japan)	*Nectoneanthes oxypoda* (Marenzeller, 1879)	Sato (2013, 2017), present study
	31. N. (*Leptonereis*) *distorta* Treadwell, 1936; (China)	*Tylorrhynchus heterochaetus* (Quatrefages, 1866)	Pettibone (1971)
	32. N. (*Neanthes*) *amoyensis* Treadwell, 1936; (China)	*N. amoyensis* (Treadwell, 1936)	Hartman (1956)
	33. N. (*Neanthes*) *linea* Treadwell, 1936; (China)	*Perinereis linea* (Treadwell, 1936)	Hartman (1938), Wu (1967), Arias et al. (2013), present study
	34. N. (*Neanthes*) *orientalis* Treadwell, 1936; (China)	*Perinereis linea* (Treadwell, 1936) syn. nov.	present study
	35. N. (*Neanthes*) *virens* Sars, 1835 *sensu* Annenkova, 1938; Uschakov, 1965; (Norway)	*Alitta brandti* Malmgren, 1865	Khlebovich (1996)

Table 60. Continued.

Subfamily genus	Nominal species	Current status	References
Nereis	*36. N. abbyssa* Imajima, 2009; (Japan)	valid	Imajima (2009)
	37. N. cultrifera sensu Izuka, 1912; (Naples, Italy)	*Perinereis euiini* Park & Kim, 2017	present study
	38. N. cylindrata Ehlers, 1868; (Rijeka Bay)	*N. zonata* Malmgren, 1867	Fauvel (1913)
	39. N. denhamensis Augener, 1913 *sensu* Imajima, 1972; Wu et al., 1985; Paik, 1977; Sato, 2017; (Australia)	*N.* sp. nov. 1	present study
	40. N. dyamushi Izuka, 1912; (Japan)	? *Alitta brandti* Malmgren, 1865	present study
	41. N. ezoensis Izuka, 1912; (Japan)	*N. vexillosa* Grube, 1851	Annenkova (1937)
	42. N. falcaria multignatha Wu, Sun & Yang, 1981; (China)	valid	Wu et al., (1985)
	43. N. grubei (Kinberg, 1866); (Chile)	valid	Wu et al., (1985)
	44. N. heterocirrata Treadwell, 1931; (Japan)	valid	Treadwell (1931), Wu (1967), Imajima (1972), Wu et al. (1985), Paik (1977)
	45. N. huanghaiensis Wu, Sun & Yang, 1981; (China)	valid	Wu et al., (1985)
	46. N. ijimai Izuka, 1912; (Japan)	*Nectoneanthes oxypoda* (Marenzeller, 1879)	Sato (2013, 2017)
	47. N. izukai Okuda, 1939; (Japan)	valid	Okuda (1939), Imajima (1972)
	48. N. japonica Izuka, 1908; (Japan)	*Hediste japonica* (Izuka, 1908)	Sato (2003, 2016), present study
	49. N. lithothamnica Annenkova, 1938; (Russian Far East)	valid	Annenkova (1938), Uschakov (1965)
	50. N. longior Khlebovitch & Wu, 1962; (China)	valid	Khlebovitch & Wu (1962)
	51. N. mictodonta Marenzeller, 1879; (Japan)	*Perinereis mictodonta* (Marenzeller, 1879)	Glasby & Hsieh (2006), Park & Kim (2007), Sato (2017), present study
	52. N. multignatha Imajima and Hartman, 1964; (Japan)	valid	present study
	53. N. neoneanthes sensu Imajima and Hayashi 1969; Imajima, 1972; (Alaska)	*N. multignatha*	present study
	54. N. nichollsi sensu Imajima, 1972; (Australia)	*Pseudonereis* aff. *anomala*	present study
	55. N. pelagica sensu Imajima, 1972; (Weastern Europe)	*N.* aff. *pelagica*	present study
	56. N. pelagica multignatha Imajima & Hartman, 1964 (=*N. multignatha sensu* Imajima, 1972); (Japan)	*N. multignatha*	present study

Table 60. Continued.

Subfamily genus	Nominal species	Current status	References
Nereis	*57. N. pusilla* Moore, 1903; (Japan)	*Composetia moorei* (Imajima, 1972)	Imajima (1972), Hartmann-Schröder (1985)
	58. N. sakhalinensis Okuda, 1935; (Sakhalin)	*Neanthes sakhalinensis* (Okuda, 1935)	Hartman (1959)
	59. N. shishidoi Izuka, 1908; (Japan)	*Cyclurus shishidoi* (Izuka, 1908) reinstatement, n. comb.	present study
	60. N. sinensis Wu, Sun & Yang, 1981; (China)	valid	Wu et al. (1985)
	61. N. singularis Treadwell, 1943; Khlebovich, 1996; (Atlantic Ocean)	*Ceratonereis mirabilis* Kingberg, 1866	Hartman (1956)
	62. N. surugaense Imajima, 1972; (Japan)	valid	Imajima (1972), Sato (2017)
	63. N. vexillosa sensu Imajima, 1972; (Alaska and Siberia)	*N.* sp. nov. 4	present study
	N. vexillosa sensu Annekova, 1937; Uschakov, 1965	valid	present study
	64. N. zonata Malmgren, 1867; (Arctic Ocean)	valid	Sato (2017)
	65. N. z. tigrina Zachs, 1933; (Peter the Great Bay)	*N. tigrina* Zachs, 1933; new to Korean waters	Uschakov (1965), present study
Nicon	*66. N. japonicus* Imajima, 1972; (Japan)	valid	Imajima (1972), Sato (2017)
	67. N. misakiensis Imajima & Hayashi, 1969; (Japan)	*Rullierinereis misakiensis* (Imajima & Hayashi, 1969)	Wu & Sun (1979)
	68. N. moniloceras: Imajima, 1972; Wu et al., 1985; (England)	valid	Sato (2017)
	69. N. sinica Wu and Sun, 1979; (China)	valid	Wu & Sun (1979), Sato (2017)
Paraleonnates	*70. P. uschakovi* Khlebovich &Wu, 1962; (China)	valid	Hong et al. (2012)
Perinereis	*71. P. aibuhitensis sensu* Lee et al., 1992; (Palau)	*P. linea* (Treadwell, 1936)	Arias et al. (2013), present study
	72. P. brevicirris sensu Imajima & Hartman 1964; (Australia)	*P. mictodonta* (Marenzeller, 1879)	Glasby & Hsieh (2006)
	P. brevicirris sensu Wu 1967 (in part)	*P. shikueii* Glasby & Hsieh, 2006	Glasby & Hsieh (2006)
	73. P. camiguinoides Augener, 1922; Wu et al., 1985; (Juan Fernandez Is.)	valid	Wu et al. (1985)
	74. P. cultrifera floridana sensu Rho & Lee, 1982; Wu et al., 1985; Paik, 1989; Imajima, 1996; Khlebovich, 1996; (Florida)	*P. euiini* Park & Kim, 2017	present study
	75. P. cultrifera typica sensu Wu et al., 1985; (Naples, Italy)	*P. euiini* Park & Kim, 2017	present study
	76. P. cultrifera var. *floridana sensu* Khlebovich & Wu, 1962; Uschakov & Wu, 1965; Imajima, 1972; (Florida)	*P. euiini* Park & Kim, 2017	present study

Table 60. Continued.

Subfamily genus	Nominal species	Current status	References
Perinereis	*77. P. cultrifera* var. *typica sensu* Khlebovich & Wu, 1962; Khlebovich, 1963; Uschakov & Wu, 1965; (Naples, Italy)	*P. euiini* Park & Kim, 2017	present study
	78. P. helleri (Grube, 1878); Wu, 1967; (Philippines)	valid	Wu (1967)
	79. P. neocaledonica Pruvot, 1930; Wu, 1967; Imajima et al. 1985; (New Caledonia)	valid	Sato (2017)
	80. P. nigropunctata (Horst, 1889); (Malaysia)	valid	Wu (1967)
	81. P. novaehollandiae Kinberg, 1866; Wu, 1967; (Australia)	*P. amblyodonta* (Schmarda, 1861)	Augener (1913)
	82. P. nuntia (Lamarck, 1818); Glasby & Hsieh, 2006; (Red Sea)	valid	Glasby & Hsieh, 2006
	P. nuntia sensu Paik, 1975	*P. mictodonta* (Marenzeller, 1879) or *P. wilsoni* Glasby & Hsieh, 2006	Park & Kim (2007)
	83. P. nuntia brevicirris sensu Wu et al., 1985; (Red Sea)	*P. mictodonta* (Marenzeller, 1879)	Glasby & Hsieh (2006)
	84. P. nuntia var. *brevicirris sensu* Okuda, 1938; Okuda & Yamada, 1954; Khlebovich & Wu 1962; Imajima, 1972; Paik, 1972; (Red Sea)	*P. mictodonta* (Marenzeller, 1879)	Glasby & Hsieh (2006), Park & Kim (2007)
	85. P. nuntia var. *vallata sensu* Khlebovich & Wu 1962; Paik 1972; Imajima 1972; (Chile)	*P. shikueii* Glasby & Hsieh, 2006	Glasby & Hsieh (2006)
	86. P. shikueii Glasby & Hsieh, 2006; (Taiwan)	valid; new to Korean waters	Glasby & Hsieh (2006), Salazar-Vallejo et al. (2014), present study
	87. P. singaporiensis Grube, 1878; Wu, 1967; (Singapore)	valid	Wu (1967)
	88. P. suluana (Horst, 1924); Tanaka, 2016; (Sulu Archipelago)	valid	Tanaka (2016), Sato (2017)
	89. P. vancaurica (Ehlers, 1868); Wu, 1967; (Nocobar Is.)	valid	Wu (1967)
	90. P. vancaurica tetradentata Imajima, 1972; (Japan)	*P. linea* (Treadwell, 1936) syn. nov.	present study
	91. P. wilsoni Glasby & Hsieh, 2006; (Taiwan)	valid	Glasby & Hsieh (2006), Park & Kim (2007), Salazar-Vallejo et al. (2014), Sato (2017)
Periserrula	*92. P. leucophryna* Paik, 1977; (Korea)	*Paraleonnates uschakovi* Khlebovich &Wu, 1962	Hong et al. (2012)
Platynereis	*93. P. agassizi* (Ehlers, 1868) *sensu* Uschakov (1965); (US west coast)	*Platynereis bicanaliculata* (Baird, 1863)	Hartman (1956)
	94. P. australis (Schmarda, 1861); Imajima, 1972; (Australia)	valid	Imajima (1972, 1996), Sato (2017)
	95. P. bicanaliculata (Baird, 1864) *sensu* Wu, 1967; Imajima, 1972; Wu et al., 1985; Paik, 1977; (Canada)	*P.* sp. 1 and *P.* sp. 2	present study

Table 60. Continued.

Subfamily genus	Nominal species	Current status	References
Platynereis	*96. P. dumerilii* (Audouin and M. Edwards, 1834); Wu, 1967; Imajima, 1972; Wu et al., 1985; Paik, 1977; (France)	valid	Sato (2017)
Pseudonereis	*97. P. anomala* Gravier, 1901; Wu, 1967; (Australia)	valid	Wu (1967)
	98. P. formosa sensu Wu, 1967; (Hawaii)	*Pseudonereis* sp. nov.	present study
	99. P. gallapagensis Kinberg, 1866; Wu, 1967; Imajima, 1972; Wu et al., 1985; Paik, 1977; (Galapagos Is.)	valid	Wu (1967), Imajima (1972), Wu et al. (1985), Paik (1977), Sato (2017)
	100. P. rottnestiana Augener, 1913; Okuda, 1938; Imajima, 1972; (Australia)	*P. anomala* Gravier, 1901	Bakken (2007), Sato (2017)
	101. P. variegata sensu Imajima, 1972; Wu et al., 1985; Paik, 1977; Sato, 2017; (Chile)	*Pseudonereis* sp. nov.	present study
Rullierinereis	*102. R. elytrocirra* Wu & Sun, 1979; Wu et al., 1985; (China)	valid	Wu et al. (1985)
	103. R. profunda Imajima, 2009; (Japan)	valid	Imajima (2009), Sato (2017)
Sinonereis	*104. S. heteropoda* Wu & Sun, 1979; Wu et al., 1985; (China)	valid	Wu & Sun (1979), Wu et al. (1985)
Tylorrhynchus	*105. T. chinensis* Grube, 1866; Zaks, 1933; Uschakov, 1965; (China)	*T. heterochaetus* (Quatrefages, 1866)	Hartman (1959)

Check List of Northeast Asian Nereidid Species

Check List of Northeast Asian Nereidid species

The species name marked with an Asterisk (*) indicates the species revised in this study.

Phylum Annelida

Class Polychaeta Grube, 1850

Subclass Errantia Audouin and H Milne Edwards, 1832

Order Phyllodocida Dales, 1962

Suborder Nereidiformia Glasby, 1993

Superfamily Nereidoidea Blainville, 1818

Family Nereididae Blainville, 1818

Subfamily Namanereidinae Blainville, 1818

Genus *Namalycastis* Hartman, 1959

1. *Namalycastis longicirris* (Takahashi, 1933)

Lycastis longicirris Takahashi, 1933: 41–46, figs. 1–6.

Namalycastis longicirris: Wu and Chen, 1963: 17–19, pl. V1–8; Wu et al., 1985: 46–47, fig. 23; Salazar-Vallejo et al., 2014: 22.

Distribution – China, Taiwan. Type locality: Taiwan.

2. *Namalycastis hawaiiensis* (Johnson, 1903)

Lycastis hawaiiensis Johnson, 1903: 210–212, pl. XVI, figs. 11– 13, pl. XVII, figs. 17–23.

Namalycastis hawaiiensis: Sato, 2017: 19, table 19.1.

Distribution – Japan. Type locality: Hawaii

3. *Namalycastis indica* (Southern, 1921)

Lycastis indica Southern, 1921: 578–582, pl. XIX, fig. 2A–J, text fig. 2a–d.

Namalycastis indica: Wu, 1967: 51, fig. 2.

Distribution – Taiwan. Type locality: India, Calcutta region.

Genus *Namanereis* Chamberlin, 1919

4. *Namanereis littoralis* (Grube, 1872) species group

Lycastis littoralis Grube, 1872: 47.

Lycastopsis augeneri Okuda, 1937: 307–309, 2 figs; Uschakov, 1955: 204; fig. 62 A–E; Imajima, 1972: 39–40, fig. 1a–f, 7; 1996: 107, fig. 85a–d; Paik, 1977: 15, fig. 1A–C; 1982: 781, pl. 10i–j; 1989: 282, text fig. 59A, B; Uschakov and Wu, 1979: 59–60; Wu et al., 1985: 48–49, fig. 24 A–F.

Namanereis littoralis species group: Sato, 2017: 19, table 19.1.

Distribution –China, Japan, Korea, Russian Far East. Type locality: Brazil.

Subfamily Gymnonereidinae Banse, 1977

Genus *Ceratocephale* Malmgren, 1867

5. *Ceratocephale borealis* Wesenberg-Lund, 1950

Ceratocephale borealis Wesenberg-Lund, 1950; Imajima, 2009

Distribution – Japan. Type locality: Greenland.

Genus *Tambalagamia* Pillai, 1961

6. *Tambalagamia fauveli* Pillai, 1961

Tambalagamia fauveli Pillai, 1961: 3–7, figs. 1a–g, 2a–f; Imajima, 1972: 44–46; figs. 3a–l, 7; Paik, 1982: 37–38, pl. 10k, l, m; Wu et al., 1985: 49–51, fig. 25A–M.

Ceratocephale sibogae: Khlebovich and Wu, 1962: 35, pl. I, B–E.

Distribution – China, Japan, Korea. Type locality: Ceylon, Sri Lanka.

Subfamily Nereidinae Blainville, 1818

Genus *Alitta* Kinberg, 1865

7. *Alitta* cf. *brandti* Malmgren, 1865*

Alitta brandti Malmgren, 1865: 183–184; Khlebovich, 1996: 113–114, taf. XXI.

Nereis dyamushi Izuka, 1912, 169–171, pl. 18, figs. 1–7.

Neanthes virens: Imajima and Hartman, 1964, 145–146; Imajima, 1972: 110–113, fig. 33; 1996: fig. 113a–i.

Distribution – Japan, Korea, Russian Far East. Type locality: Arctic Ocean.

Genus *Ceratonereis* Kinberg, 1865

8. *Ceratonereis* (*Composetia*) *gorbunovi* (Uschakov, 1950)

Nereis (*Ceratonereis*) *gorbunovi* Uschakov, 1950: 183–184, fig. 18; Uschakov, 1965: 189, fig. 64A–D.

Ceratonereis (*Composetia*) *gorbunovi*: Read and Fauchald (2017).

Distribution – Russian Far East. Type locality: Sea of Okhotsk.

9. *Ceratonereis japonica* Imajima, 1972

Ceratonereis japonica Imajima, 1972: 69–71, figs. 15a–p, 17; 1996: 121, fig. 96; Wu et al., 1985: 185–187, fig. 105A–F; Sato, 2017: 482, table 19.1.

Distribution – China, Japan. Type locality: Koniya, Amami-oshima.

10. *Ceratonereis mirabilis* Kinberg, 1865

Ceratonereis mirabilis Kinberg, 1865: 170; Imajima and Hartman, 1964: 141–142; Paik, 1977: 35–35, fig. 12A–G; 1982: 785, pl. 11m–o; 1989: 299–301, text fig. 67A–C; Imajima, 1972: 64–66, figs. 13a–s, 17; 1996: 116, fig. 93a–J; 2003: 170; Wu et. al., 1985: 180–183, figs. 102A–H, 103A–D.

Distribution – China, Japan, Korea. Type locality: Brazil.

Genus *Composetia* Hartmann-Schröder, 1985

11. ***Composetia hircinicola*** **(Eisig, 1870)**

Nereis hircinicola Eisig, 1870: 103–105, pl. 11, figs. 3, 4.

Ceratonereis hircinicola: Imajima, 1972: 67–69, figs. 14a–m; 1996: 118–119, fig. 94a–k, 94´a–e; 2003: 168–170, fig. 89a–o; Wu et al., 1985: 183–185, fig. 104A–L; Paik, 1982: 785, pl. 11; 1989: 303–304, pl. 23, fig. 59, text fig. 69; Rho and Lee, 1982: 38, pl. 3, fig. 1; Sato, 2017: 482, Table 19.1.

Distribution – China, Japan, Korea. Type locality: Naples, Italy.

12. ***Composetia moorei*** **(Imajima, 1972)**

Nereis pusilla Moore, 1903: 428–429, pl. 24, figs. 25–27; Izuka, 1912, 156–157.

Nereis (*Ceratonereis*) *pusilla*: Uschakov, 1965, 188.

Ceratonerei pusilla: Imajima and Hartman, 1964: 141.

Ceratonereis moorei Imajima, 1972: 72.

Composetia moorei: Sato, 2017: 483, Table 19.1

Distribution – Japan. Type locality: Suruga Bay, Japan.

13. ***Composetia*** **sp. nov.***

Distribution – Korea. Type locality: Jeju-do, Korea.

Genus *Cheilonereis* Benham, 1916

14. ***Cheilonereis shishidoi*** **(Izuka, 1912)*, reinst., n. comb.**

Nereis shishidoi Izuka, 1912: 177–178, pl. 19, figs. 10–18.

Cheilonereis cyclurus: Okuda, 1950, 52–53; Uschakov, 1965: 194, fig. 67A–F; Imajima and Hartman, 1964: 142; Uschakov and Wu, 1965: 201; Imajima, 1972: 50–53, figs. 6, 7; 1996: 112, fig. 89; Paik, 1977: 26–28, fig. 9A–G; 1982: 784, pl. 11d–f; 1989: 293–295, pls. 20, 21, fig. 54a (1–4), text fig. 64A–h; Wu et. al., 1985: 79–80, fig. 43A–J; Park et al., 2017: 669–671, fig. 1A, B.

Distribution – China, Japan, Korea, Russian Far East. Type locality: Yuriage, Japan.

Genus *Hediste* Malmgren, 1867

15. *Hediste atoka* Sato and Nakashima, 2003*

Hediste atoka Sato and Nakashima, 2003: 426–435, figs. 1, 10, 28–43; Sato, 2017: 486, Table 19.1.

Neanthes japonica: Kikuchi, 1998: 125–146, figs. 1–12.

Distribution – Japan, Korea. Type locality: Aomori, northern Honshu, Japan.

16. *Hediste diadroma* Sato and Nakashima, 2003*

Hediste diadroma Sato and Nakashima, 2003: 415–426, figs. 10, 16–27, 38–43; Sato, 2017: 485, Table 19.1.

Nereis japonica: Kagawa, 1955: 11–16, fig. 5; Okada, 1960: 63–71, pls. 1–4.

Neanthes japonica: Sun et al., 1980: 100–110, figs. 1–3; Sato and Osanai, 1986: 263–270, figs. 1–7; Qiu and Wu, 1993: 360–367, figs. 1, 2.

Distribution – Japan, Korea (new to Korea from this study). Type locality: Aomori, northern Honshu, Japan.

17. *Hediste japonica* (Izuka, 1908)*

Nereis japonica Izuka, 1908: 295–305, 4 text figs.; 1912: 163–169, pl. 17, figs. 14–16.

Nereis japonica: Khlebovich et. al., 1982: 1110–1113 (populations of Yellow Sea).

Neanthes japonica: Paik, 1972: 132–135; 1977: 196–198; 1978: 371; 1979: 54; 1980: 40; 1982: 789; 1989: 335–338

Hediste japonica: Sato and Nakashima, 2003: 405–415, figs. 2–15, 38–41, 43; Sato, 2017: 485, Table 19.1.

Not *Hediste japonica*: Imajima, 1972: 102–105 (= *H. diadroma* or *H. atoka*); Imajima, 1996: 139 (= *H. diadroma* or *H. atoka*).

Distribution – Japan, Korea. Type locality: Kojima Bay in Seto Inland Sea, Japan.

18. *Hediste* sp.*

Distribution – Korea. Type locality: estuary of Han-River, Korea.

Genus *Leonnates* Kinberg, 1865

19. *Leonnates nipponicus* Imajima, 1972

Leonnates nipponicus Imajima, 1972: 41–43, figs. 2a–l, 7; Paik, 1977: 20–22, fig. 7A–G; 1982: 783, pl. 10q–s; 1989: 288–289, pls. 19, 20, fig. 52(1–3), text fig. 62; Qiu and Qian; 2000: 1137–1138; Sato, 2017: 481, table 19.1.

Distribution – Japan, Korea. Type locality: Amami-oshima, Japan.

20. *Leonnates persicus* Wesenberg-Lund, 1949

Leonnates persica Wesenberg-Lund, 1949: 275–277, figs. 11, 12; Khlebovich and Wu, 1962, 36, 45–47; Khlebovich, 1963, 52; Wu et al., 1985, 73–75, figs. 39A–J, 40A–C; Khlebovich, 1996, 100, pl. 12.

Leonnates persicus: Qiu and Qian; 2000: 1129–1135, figs. 8B–C, 9A–C, 10A–E, 11A–D; Sato and Kubo, 2009: 798–803, figs. 1–6; Sato, 2017: 481, Table 19.1.

Distribution – China, Japan, Korea. Type locality: Persian Gulf.

Genus *Neanthes* Kinberg, 1865

21. *Neanthes acuminata* (Ehlers, 1868)

Nereis acuminata Ehlers, 1868: 552.

Neanthes caudata (*sensu* Delle Chiaje, 1827): Imajima, 1972: 105–108, figs. 31a–l, 37; 2003: 171–172; Paik, 1977: 198–200, fig. 28a–g; 1982: 789, pl. 14g–i; 1989: 338–339, pl. 32, fig. 77(1, 2), text fig 88.

Neanthes acuminata: Read and Fauchald, 2017.

Distribution – Korea, Japan.

22. ***Neanthes flava* Wu, Sun and Yang, 1981**

Neanthes flava Wu, Sun and Yang, 1981: (1985, english ver.) 159–161, fig. 89A–J.

Distribution – Only known from type locality. Type locality: Shanhaiguan, China.

23. ***Neanthes glandicincta* (Southern, 1921)**

Nereis glandicincta Southern, 1921: 589–593, pl. 23, fig. 9a–l, text figs. 5a–e.

Neanthes glandicincta: Wu, 1967: 62–64, fig. 8a–c; Wu et al., 1985: 150–151, fig. 84A–I.

Ceratonereis burmensis Monro, 1937: 532–536, fig. 1a–f; Wu, 1967: 51–54, fig. 3a–d; Uchida, 1990.

Distribution – Taiwan, Japan. Type locality: Chlika Lake, India.

24. ***Neanthes donghaiensis* Wu, Sun and Yang, 1981**

Neanthes donghaiensis Wu, Sun and Yang, 1981: (1985, english ver.) 146–148, fig. 82A–I.

Distribution – China (East China Sea). Type locality: Fujian, China.

25. ***Neanthes pachychaeta* (Fauvel, 1918)**

Ceratonereis pachychaeta Fauvel, 1919: 403, figs. 22–25, text fig. 8; Imajima, 1972: 72–75, figs. 16a–p, 17; 1996: 123, fig. 98; Wu et al., 1985: 187–189, fig. 106A–G.

Neanthes pachychaeta: Sato, 2017: 486, table 19.1.

Distribution – China (East China Sea), Japan (middle and southern part). Type locality: Madagascar.

26. ***Neanthes sakhalinensis* (Okuda, 1935)**

Nereis sakhalinensis Okuda, 1935: 54–57, fig. 1; Uschakov, 1965: 190–191, fig. 66A–F.

Neanthes sakhalinensis: Hartman, 1959: 251.

Distribution – Russia Far East (South Sakhalin). Type locality: South Sakhalin, brackish lake.

27. *Neanthes succinea* (Leuckart, 1847)

Nereis succinea Leuckart, 1847: 154–156, pl. 2, figs, 9, 11.

Neanthes succinea: Imajima, 1972: 108–110, figs. 32a–k; 1996: 142, fig. 114a–i; Paik, 1977: 202–204, fig. 30A–F; 1982: 789, pl. 14m–o; 1989: 342, pl. 33, fig. 79(1–3), text fig. 90A–C; Wu et al., 1985: 156–159, fig. 88A–J; Yang and Sun, 1988: 37–38, fig. 7f–i; Khlebovich, 1996: 103–104; Hong et al., 1997: 885; Lee et al., 2003: 192–197; Sato, 2013: 35–42, figs. 3D–F, 4B, 15–17.

Distribution – China, Japan, Korea, Russian Far East. Type locality: Helgoland, German North Sea.

Genus *Nectoneanthes* Imajima, 1972

28. *Nectoneanthes oxypoda* (Marenzeller, 1879)*

Nereis (*Alitta*) *oxypoda* Marenzeller, 1879: 120–122, pl. 2, fig. 3.

Nereis ijimai Izuka, 1912: 174–176, pl. 2, fig.1, pl. 19, figs. 1–9.

Nereis oxypoda: Izuka, 1912: 171–173, pl. 18, figs. 8–11 (in part); Mori et al., 1932: 3, pl. 1, fig. 2, pl. 3, figs. 1–6.

Nereis (*Neanthes*) *oxypoda*: Treadwell, 1936: 268; Uschakov, 1965: 187–188, fig. 63E.

Neanthes ijimai: Imajima and Hartman, 1964: 144–145.

Nectoneanthes ijimai: Imajima, 1972: 117–119; 1996: 143, fig. 115; Wu et al., 1985: 161–163, fig. 90.

Nectoneanthes oxypoda: Imajima, 1972: 116–117, fig. 36a–d (in part, epitokes); 1996: 145, fig. 116' (in part, epitokes); Sato, 2013: 4–24, figs. 1, 2, 3A–C, 4A, 5–9; Sato, 2017: 487, table 19.1.

Nectoneanthes latipoda Paik, 1973: 81–84, fig. 1a–j; Imajima, 1996: 146–147, figs. 117–117'; Khlebovich, 1996: 116, pl. 23; Nishi et al., 1998: 199; Lee et al., 2003: 191; Choi et al., 2005: 387; Yamanishi and Sato, 2007.

Nectoneanthes multignatha Wu, Sun and Yang, 1981: (1985, english ver.), 163–164, fig. 91.

Nectoneanthes alatopalpis: Wu et al., 1985: 168–169, fig. 94; Khlebovich, 1996: 115.

Nectoneanthes donghaiensis He, 1987: 346–349, figs. 1–7.

Nectoneanthes singularis: Khlebovich, 1996: 115.

Distribution – China, Japan, Korea, Russian Far East. Type locality: Yokohama, Japan.

29. *Nectoneanthes uchiwa* Sato, 2013*

Nectoneanthes uchiwa Sato, 2013: 24–34, figs. 4A, 9–14; Sato, 2017: 487, table 19.1.

Nereis oxypoda Izuka, 1912: 171–173, pl. 18, figs. 8–11 (in part); Mori et al., 1932: 3, pl. 1, fig. 2, pl. 3, figs. 1–6 (in part); Okuda, 1933: 247, pl. 13, figs. fpl. 1, fig. 2, pl. 3, figs. 1–6h; Monro, 1934: 362–363 (in part).

Nereis (*Neanthes*) *oxypoda*: Khlebovich, 1963: 55.

Neanthes oxypoda: Imajima and Hartman, 1964: 145.

Nectoneanthes oxypoda: Imajima, 1972: 113–118, figs. 35b, c (in part, atokes); Paik, 1972: 135, fig. 4; Paik, 1973: 82–84, figs. 1k–l, 2; Wu et al., 1985: 164–167, figs. 92–93; Yang and Sun, 1988: 39, figs. 8A–D; Imajima, 1996: 144–145, figs. 116 b, c (in part, atokes); Khlebovich, 1996: 115–116, pl. 22; Lee et al., 2003: 189–190; Yamanishi and Sato, 2007: 183.

Distribution – China, Japan, Korea. Type locality: Kojima Bay in Seto Inland Sea, Japan.

Genus *Nereis* Linnaeus, 1758

30. *Nereis abbyssa* Imajima, 2009

Nereis abbyssa Imajima, 2009: 82–85, fig. 19A–F, 20A–J.

Distribution – Only known from type locality. Type locality: Off Sanriku, Japan.

31. *Nereis amoyensis* Treadwell, 1936

Nereis (*Neanthes*) *amoyensis* Treadwell, 1936: 272–273, fig. 19j–m.

Nereis amoyensis: Hartman, 1959: 252.

Distribution – Only known from type locality. Type locality: Amoy, China.

32. *Nereis falcaria multignatha* Wu, Sun and Yang, 1981

Nereis falcaria multignatha Wu, Sun and Yang, 1981: (1985, english ver.), 141–142, fig. 80A–I.

Distribution – Only known from type locality. Type locality: Bohai Sea and East China Sea, China.

33. *Nereis grubei* (Kinberg, 1866)

Heteronereis grubei Kinberg, 1866: 170.

Nereis grubei: Khlebovich and Wu, 1962: 268, pl. IIA–D; Wu et al., 1985: 130–132, fig. 73A–J.

Distribution – China (Yellow Sea). Type locality: Chile.

34. *Nereis heterocirrata* Treadwell, 1931*

Nereis heterocirrata Treadwell, 1931: 1–2, text fig. 1a–c; Imajima and Hartman, 1964: 146–147; Wu, 1967: 62, fig. 7; Imajima, 1972: 125–129, figs. 41, 42, 51; 1996: 152–153, figs. 120a–k, 120'a–f; Paik, 1977: 187–189, fig. 23; 1978: 370–371, pl. 4; 1982: 788, pl. 13; 1984b: 148; Paik, 1989: 329–330, pls. 29, 30, figs. 72a(1, 2), b(1–3), text fig. 83; Sato, 2017: 487, table 19.1.

Distribution – China, Japan, Korea, Taiwan (Yellow Sea, East China Sea). Type locality: Japan.

35. *Nereis huanghaiensis* Wu, Sun and Yang, 1981

Nereis huanghaiensis Wu, Sun and Yang, 1981: (1985, english ver.) 133–135, fig. 75A–L.

Distribution – Only known from type locality. Type locality: Huanghai Sea, China.

36. *Nereis izukai* Okuda, 1939

Nereis izukai Okuda, 1939: 229–230, fig. 5; Imajima and Hartman, 1964: 147; Imajima, 1972: 132–133; 157, fig. 123.

Distribution – Only known from type locality. Type locality: Off Kinkazan, northern Japan.

37. *Nereis lithothamnica* Annenkova, 1938

Nereis lithothamnica Annenkova, 1938: 159–160, figs. 9, 10; Uschakov, 1965: 192, fig. 66N–P.

Distribution – Only known from type locality. Type locality: East Sea (Sea of Japan).

38. *Nereis longior* Khlebovitch and Wu, 1962

Nereis longior Khlebovitch and Wu, 1962: 269–270, pl. 3A; Wu et al., 1985: 135–137, fig. 76A–K; Paik, 1989: 318–319, pl. 28, fig 66(1–3), text fig. 76.

Distribution – China, Korea (Yellow Sea). Type locality: Bohai Sea.

39. *Nereis multignatha* Imajima and Hartman, 1964*

Nereis pelagica multugnatha Imajima and Hartman,1964: 148–149.

Nereis multignatha: Imajima, 1972: 136–138, figs. 45a–k, 51; 1996: 156, fig. 122a–i; Paik, 1975a, 414–415, pl. 5, figs. 35–43; 1977: 185–187, fig. 22; 1982: 788, pl. 13j–l; Wu et al., 1985: 114–117, figs. 63A–I, 64A–F.

Nereis pelagica: Izuka, 1912: 154–156, pl. 17, figs. 1–6.

Nereis neoneanthes: Imajima and Hayashi, 1969: 10, pl. 1, figs. a–m; Imajima, 1972: 133–135, figs. 30a–m, 51; 1996: 154–155, figs. 121a–i, 121'a–f; 2003: 173; Paik, 1975a: 413–414, pl. 4, figs. 25–34; 1977: 182–185, fig. 21; 1982: 788, pl. 13g–i; 1989: 324–326, pls. 28, 29, fig. 70(1–3), text fig. 80A–C; Wu et al., 1985: 99–101, figs. 52A–I, 53A–E.

Distribution – China, Japan, Korea. Type locality: Japan.

40. *Nereis* aff. *pelagica* Linnaeus, 1758*

Nereis pelagica: Moore, 1903: 431; Uschakov, 1965: 191, fig. 66G–J; Imajima and Hartman, 1964: 147–148; Imajima, 1972: 142–146, figs. 48a–m, 49a–d, 51; Paik, 1977: 193–195, fig. 26A–F; Wu et al., 1985: 120–123, figs. 67A–J, 68A–E.

Distribution – China, Japan, Korea, Russian Far East. Type locality: Unknown.

41. *Nereis sinensis* Wu, Sun and Yang, 1981

Nereis sinensis Wu, Sun & Yang, 1981: (1985, english ver.), 137–140, figs. 77A–G, 78A–E.

Distribution – Only known from type locality. Type locality: China (Huanghai Sea or East China Sea).

42. *Nereis surugaense* Imajima, 1972

Nereis surugaense Imajima, 1972: 129–132, figs. 48a–l, 51; Paik, 1982: 787, pl. 12s–u; 1989: 320–321, pl. 28, fig. 67(1–4).

Distribution – Japan, Korea. Type locality: Suruga Bay, Japan.

43. *Nereis tigrina* Zachs, 1933*

Nereis zonata var. *tigrina* Zachs, 1933: 128.

Nereis tigrina: Annenkova, 1938: 158–159, fig. 8; Uschakov, 1965: 192, fig. 66L–M.

Distribution – Korea, Russian Far East. Type locality: Peter the Great Bay, Russia.

44. *Nereis vexillosa* Grube, 1851

Nereis vexillosa Grube, 1851: 4–6, Taf. I. Fig. 2, 4, 4a, 5, 6; Annekova, 1937: 160; Uschakov, 1965: 190, fig. 65B–G. Not by Imajima, 1972; Paik, 1977.

Nereis ezoensis Izuka 1912: 173–174, pl. XVIII, figs. 12–20; Okuda, 1938, 91; 1939, 230; Okuda and Yamada, 1954, 184, text fig. 3C.

Distribution – Japan (northern part), Russia Far East. Type locality: North Pacific Ocean, Alaska and Siberia.

45. *Nereis zonata* Malmgren, 1867

Nereis zonata Malmgren, 1867: 46–47, tab. 5, figs. 34, 34A, 34C, 34C', 34D, 37.

Nereis cylindrata: Izuka, 1912: 153–154, pl. 16, fig. 16.

Nereis zonata: Uschakov, 1965: 192, fig. 66K; Imajima, 1972: 146–149, fig. 50a–l; Paik, 1977: 191–193, fig. 25A–G; 1982: 788, pl. 13s–u; Wu et al., 1985: 126–128, fig. 71A–J.

Distribution – China, Japan, Korea, Russian Far East. Type locality: Svalbard, Japan.

46. *Nereis* sp. nov. 1*

Nereis denhamensis: Imajima, 1972: 120–122, figs. 30a–m, 51; 1996: 148–149, figs. 118a–j, 118'a–g; Paik, 1977: 182, fig. 20A–F; 1982: 787, pl. 13d–f; 1989: 323–324; Wu et al., 1985: 95–97, fig. 50A–F.

Distribution – China, Japan, Korea. Type locality: Jejudo, Korea.

47. *Nereis* sp. nov. 2*

Distribution – Type locality only. Type locality: Wangdol reef, East Sea, Korea.

48. *Nereis* sp. nov. 3*

Distribution – Type locality only. Type locality: Tongyung-si, Korea.

49. *Nereis* sp. nov. 4*

Nereis vexillosa: 138–142, figs. 46a–m, 47a–d; 1996: 158–159, figs. 124a–k, 124’a–d; Paik, 1977: 189–191, fig. 24A–G; 1982: 788, pl. 13p–r; Wu et al., 1985: 117–120, figs. 65A–J, 66A–E.

Distribution – China, Japan, Korea. Type locality: Korea (Socheongdo Is., Yellow Sea).

Genus *Nicon* Kinberg, 1866

50. *Nicon japonicus* Imajima, 1972

Nicon japonicus Imajima, 1972: 57, figs. 10a–n, 11; Wu et al., 1985: 58–60, fig. 30A–N.

Distribution – China (South China Sea). Type locality: Ariake Sea, Japan.

51. *Nicon moniloceras* (Hartman, 1940)

Leptonereis glauca moniloceras Hartman, 1940: 217.

Nicon moniloceras: Khlebovich and Wu, 1962: 35; Imajima, 1972: 53, figs. 8a–j, 11; Wu et al., 1985: 56–58, fig. 29A–T.

Distribution – China (Yellow Sea), Japan. Type locality: California, Northeast Pacific.

52. *Nicon sinica* Wu and Sun, 1979

Nicon sinica Wu and Sun, 1979: 99–101, fig. 3; Wu et al., 1985: 60–61, fig. 31A–E); Paik, 1997: 152–157, fig. 2a–j; Miura, 1990.

Distribution – China (Huanghai Sea, South China Sea), Japan (Off Daio-zaki, Mie Prefecture), Korea (Yellow Sea). Type locality: China.

Genus *Paraleonnates* Khlebovitch and Wu, 1962

53. *Paraleonnates uschakovi* Khlebovich and Wu, 1962

Paraleonnates uschakovi Khlebovitch and Wu, 1962: 265–267, 271–272, fig. 1; Hong et al., 2012: 49–62, figs. 2A, D, 3A–C, 4A, B, 5A–L, 6A–D, 7A–D, 8A–E.

Periserrula leucophryna Paik, 1977: 153–155, 220–221, fig. 8A–J; 1978: 3, pl. 1, figs. 7–9; 1982: 783, pl. 11a–c.

Distribution – China (South China Sea), Korea (Yellow Sea). Type locality: Hainan, China.

Genus *Perinereis* Kinberg, 1865

54. *Perinereis amblyodonta* (Schmarda, 1861)

Nereilepas amblyodonta Schmarda, 1861: 106, fig. A–B, a–b, K, pl. 31, fig. 245.

Perinereis novaehollandiae Kinberg, 1866: 175; Wu, 1967: 64.

Perinereis amblyodonta: Augener, 1913: 174–175.

Distribution – Taiwan. Type locality: New South Wales.

55. *Perinereis camiguinoides* (Augener, 1922)

Nereis (*Perinereis*) *camiguinoides* Augener, 1922: 180–183, fig. 4a–d, tafel fig 2.

Perinereis camiguinoides: Wu et al., 1985, 197–199, fig. 112A–J.

Distribution – China (Yellow Sea). Type locality: Juan Fernandez Islands, Chile.

56. *Perinereis euiini* Park and Kim, 2017*

Perinereis euiini Park and Kim, 2017: 252–260, figs. 1, 2, 3A, 4A–B, 5A–B.

Nereis cultrifera: Izuka, 1912: 151–153, pl. 16, figs. 7–14.

Perinereis cultrifera: Fauvel, 1936: 62–63; Okuda, 1938: 92; Okuda, 1950: 52, figs. i–j; Okuda and Yamada, 1954: 185, fig. 3F; Imajima and Hartman, 1964: 152; Wu, 1967: 66–67; Imajima, 1972: 88–91, figs. 24, a–l, 27; Uschakov and Wu, 1979: 64; Imajima, 1996: 128–129, figs. 102, 102′; Imajima 2003: 176; Paik, 1977: 174–176, fig. 17a–g; Paik, 1979: 41, 53, 58, figs. 7e, f; Paik, 1989: 314–315, pl. 27, figs. 64(1–4), text fig. 74a–c; Wu et al., 1985: 213–214; Sun and Yang, 2004: 186–190, figs. 106 a–j, figs. 107a–e.

Perinereis cultrifera var. *typica*: Khlebovich and Wu, 1962: 39; Khlebovich, 1963: 57; Uschakov and Wu, 1979: 64.

Perinereis cultrifera typica: Wu et. al., 1985: 214, figs. 118a–j (not figs. 121a–j).

Perinereis cultrifera var. *floridana*: Khlebovich and Wu, 1962: 39, 51; Khlebovich, 1963: 57; Imajima, 1972: 91, figs. 25a–b; Uschakov and Wu, 1979: 64.

Perinereis cultrifera floridana: Rho and Lee, 1982: 39, pl. 3, figs. 2, 3; Wu et al., 1985: 218, fig. 123a–b; Paik, 1989: 316, pl. 27, figs. 65(1–2), text fig. 75; Imajima, 1996: 130, fig. 103; Sun and Yang, 2004: 186–190, fig. 108a–b.

Distribution – China (Yellow Sea, East South China), Japan, Korea, Taiwan. Type locality: Changwon-si, Korea.

57. *Perinereis helleri* (Grube, 1878)

Nereis (*Perinereis*) *helleri* Grube, 1878: 81–82.

Perinereis helleri: Wu, 1967: 66.

Distribution – Taiwan. Type locality: Philippines.

58. *Perinereis linea* (Treadwell, 1936)*

Nereis (*Neanthes*) *linea* Treadwell, 1936: 268–270, fig. 19a–e.

Nereis (*Neanthes*) *orientalis* Treadwell, 1936: 270–272, fig. 19f–i. syn. nov.

Perinereis linea: Wu, 1967: 68–69, fig. 10a–d; Arias et al., 2013: 1–12, figs. 2A–H, 3A, B, E, G–J, 4A–F.

Perinereis vancaurica tetradentata Imajima, 1972: 86–88, figs. 23a–i, 27; Paik, 1975: 7, pl. 6, figs. 44–46; 1977: 172–174, fig. 16a–f; 1989: 309–311, fig. 72a–e, text fig. 72. syn. nov.

Perinereis aibuhitensis: Wu et al., 1985: 189–193, figs. 107–109 (in part); Lee et al, 1992: 1–10, figs. 2, 3; Sun and Yang, 2004: 180–183, figs. 101–103 (in part); Kim et al, 2017: 869–870.

Distribution – China, Japan, Korea, Taiwan (Yellow Sea, Sumida River, East China Sea). Type locality: Amoy, China.

59. *Perinereis mictodonta* (Marenzeller, 1879)*

Nereis mictodonta Marenzeller, 1879: 118, pl. 2, fig. 2; Izuka, 1912: 148, pl. 16, figs. 1–6.

Perinereis nuntia var. *brevicirris*: Fauvel, 1936: 63; Okuda, 1938: 92; 1939: 231; 1940: 12; Okuda and Yamada, 1954: 184, fig. 3e; Khlebovich and Wu, 1962: 51, pl. 3, fig. 3; Imajima, 1972: 94, fig. 26l–m; Paik, 1972: 131, fig. 2i–j; Wu et al., 1985: 208, fig. 120a, b.

Perinereis brevicirris: Imajima and Hartman, 1964: 151; Wu, 1967: 71, fig. 11a–d (in part).

Perinereis nuntia: Paik, 1975: 242, fig. 1a–d (in part); 1989: 311, pl. 26, 27, figs. a, b(1, 2), c(1, 2), text fig. 73A–G (in part).

Perinereis nuntia brevicirris: Wu et al. 1985: 208-210, fig. 120a, b.

Perinereis mictodonta: Wilson and Glasby, 1993: 264; Glasby and Hsieh, 2006: 558, fig. 5A–E; Park and Kim, 2007: 76–80, figs. 2A–D, 3A, 4A, 5A–B, 6.

Perinereis sp. 1: Chen et al, 2002: 19.

Distribution – China, Japan, Korea, Taiwan (Yellow Sea, South China Sea, East China Sea). Type locality: Japan.

60. *Perinereis neocaledonica* Pruvot, 1930

Perinereis neocaledonica Pruvot, 1930: 50–54, pl. 47, figs. 13–16, pl. 48, figs. 1–4; Wu, 1967: 72–74, fig. 12a–d.

Distribution – Taiwan. Type locality: Philippines.

61. *Perinereis nigropunctata* (Horst, 1889)

Nereis nigropunctata Horst, 1889: 171–174, pl. 8, figs. 1–3.

Perinereis nigropunctata: Wu, 1967: 64–66, fig. 9a–d.

Distribution – Taiwan. Type locality: Malaysian.

62. *Perinereis nuntia* (Savigny in Lamarck, 1818)

Lycoris nuntia Savigny in Lamarck, 1818: 313.

Perinereis nuntia var. *typica*: Khlebovitch 1963: 58.

Perinereis nuntia typica: Wu et al., 1985: 213, fig. 120c, d.

Perinereis nuntia: Glasby and Hsieh, 2006: 563–565, fig. 6A–F.

Distribution – Taiwan. Type locality: Gulf of Suez.

63. *Perinereis shikueii* Glasby and Hsieh, 2006*

Perinereis shikueii Glasby and Hsieh, 2006: 565–568, fig. 8A–F.

Perinereis brevicirris: Wu, 1967: 71, fig. 11a–d (in part).

Distribution – Taiwan, Korea (new to Korea from this study). Type locality: Chuwei, Taiwan.

64. *Perinereis singaporiensis* (Grube, 1878)

Nereis (*Perinereis*) *singaporiensis* Grube, 1878: 84–85.

Perinereis singaporiensis: Wu, 1967: 64–66, fig. 9a–d.

Distribution – Taiwan. Type locality: Singapore.

65. *Perinereis suluana* (Horst, 1924)

Nereis (*Perinereis*) *suluana* Horst, 1924: 175–176, pl. 33, fig. 9.

Perinereis suluana: Tanaka, 2016: 5–13, fig. 1A–E, 2A–F.

Distribution – Japan (Okinawa Island). Type locality: Sulu Archipelago.

66. *Perinereis vancaurica* (Ehlers, 1868)

Nereis vancaurica Ehlers, 1868: 503, pl. 20.

Perinereis vancaurica: Wu, 1967: 70–71; Wu et al., 1985: 195–197, fig.111A–J

Distribution – China (East China Sea), Taiwan. Type locality: Nicobar Islands.

67. *Perinereis wilsoni* Glasby and Hsieh, 2006 species complex*

Perinereis nuntia var. *vallata*: Khlebovich and Wu, 1962: 51, pl. 3; Paik, 1972: 131, fig. 2a–h; Imajima, 1972: 92–94, figs. 26a–k, 27; Wu et al., 1985: 210, fig. 121a–k.

Perinereis brevicirris: Wu, 1967: 71, fig. 11a–d.

Perinereis nuntia: Paik, 1975: 242, fig. 1a–d (in part); 1989: 311, pl. 26, 27, figs. a, b(1, 2), c(1, 2), text fig. 73A–G (in part).

Perinereis sp. 2: Chen et al., 2002: 19.

Perinereis wilsoni: Park and Kim 2007: 80–83, figs. 2E–H, 3B, 4B.

Distribution – China (Yellow Sea), Japan, Korea, Taiwan. Type locality: Pitou, Taiwan.

Genus *Platynereis* Kinberg, 1865

68. *Platynereis dumerilii* (Audouin and Milne Edwards, 1834)

Nereis dumerilii Audouin and Milne Edwards, 1834: 196.

Platynereis dumerilii: Imajima and Hartman, 1964: 153–154; Wu, 1967: 59–62, fig. 6a–e; Imajima, 1972: 80–82, figs. 20a–l, 22; Wu et al., 1985: 86–90, fig. 47A–L; Paik, 1977: 31–33, fig. 11A–F; 1982: 785, pl. 11j–l; 1989: 297–298, pl. 22, fig.

56(1–3), text fig. 66A–C.

Distribution – China (Yellow Sea, East China Sea), Japan, Korea, Taiwan. Type locality: La Rochelle, France.

69. *Platynereis australis* (Schmarda, 1861)

Heteronereis australis Schmarda, 1861: 101–102, pl. 31, fig. 242.

Platynereis australis: Imajima, 1972: 82–85, fig. 21a–o; 1996: 127, fig. 101; Sato, 2017: 483.

70. *Platynereis* sp. 1*

Platynereis bicanaliculata: Imajima and Hartman, 1964: 152–153 (in part); Wu, 1967: 57–58, fig. 5a–b (in part); Imajima, 1972: 76–79, figs. 18a–m; 19a–e, 22 (in part); 1996: 124–125, figs. 99a–k, 99'a–e (in part); 2003: 177–178 (in part); Wu et al., 1985: 82–86, figs. 45A–K, 46A–E (in part); Paik, 1977: 158–160, fig. 10A–G (in part); 1982: 784, pl. 11g–I (in part); 1989: 295–297, pl. 22, fig. 55(1–2), text fig. 65A–C (in part).

Distribution – China (Yellow Sea, East China Sea), Japan, Korea, Taiwan.

71. *Platynereis* sp. 2*

Platynereis bicanaliculata: Imajima and Hartman, 1964: 152–153 (in part); Wu, 1967: 57–58, fig. 5a–b (in part); Imajima, 1972: 76–79, figs. 18a–m; 19a–e, 22 (in part); 1996: 124–125, figs. 99a–k, 99'a–e (in part); 2003: 177–178 (in part); Wu et al., 1985: 82–86, figs. 45A–K, 46A–E (in part); Paik, 1977: 158–160, fig. 10A–G (in part); 1982: 784, pl. 11g–I (in part); 1989: 295–297, pl. 22, fig. 55(1–2), text fig. 65A–C (in part).

Distribution – China (Yellow Sea, East China Sea), Japan, Korea, Taiwan.

Genus *Pseudonereis* Kinberg, 1865

72. *Pseudonereis* aff. *anomala* Gravier, 1901*

Pseudonereis anomala: Wu, 1967: 54–56, fig. 4a–c.

Nereis nichollsi: Imajima, 1972: 112–124, figs. 39a–p, 40a–c, 51; 1996: 150–151, figs. 119a–k, 119'a–f; Paik, 1977: 180–181, fig. 19A–F; 1982: 787, pl. 13a–c; 1989: 322–323; Wu et al., 1985: 101–103, fig. 54A–J.

Distribution – China (Yellow Sea, East China Sea), Japan, Korea, Taiwan. Type locality: Indian Ocean.

73. *Pseudonereis gallapagensis* Kinberg, 1865

Pseudonereis gallapagensis Kinberg, 1865: 174; Okuda, 1940: 13–14, fig. 6; Wu, 1967: 55–56; Imajima, 1972: 97–99, figs. 28a–j, 11; 1996: 136, fig. 108a–i; Paik, 1977: 168–169, fig. 14A–F; 1989: 305–306, text fig. 70A, B.

Distribution – Japan, Korea, Taiwan. Type locality: Galapagos Is., Chile.

74. *Pseudonereis* sp. nov.*

Pseudonereis formosa: Wu, 1967: 56–57.

Pseudonereis variegata: Imajima, 1972: 99–101, figs. 29a–m, 11; 1996: 137, fig. 109a–k; Paik, 1977: 170–171, fig. 15; 1982: 786, pl. 12G–I, 1984: 148; 1989: 306–307, pl. 23, fig. 61a(1, 2), b(1–3), text fig. 71A–H; Wu et al., 1985: 221–223, fig. 125A–J.

Distribution – China, Japan, Korea, Taiwan. Type locality: Wando Is., Korea.

Genus *Rullierinereis* Pettibone, 1971

75. *Rullierinereis elytrocirra* Wu and Sun, 1979

Rullierinereis elytrocirra Wu and Sun, 1979: 108–111, fig. 8; Wu et al., 1985: 61–63, fig. 32A–P.

Distribution – Only known from type locality. Type locality: Huanghai Sea, China.

76. *Rullierinereis misakiensis* (Imajima and Hayashi, 1969)

Nicon misakiensis Imajima and Hayashi, 1969: 11–12, pl. 3, figs. a–k; Imajima, 1972: 55–57, figs. 9a–j, 11.

Rullierinereis misakiensis: Wu and Sun, 1979: 106–108, fig. 7; Sato, 2017: 482, table 19.1.

Distribution – Only known from type locality. Type locality: Huanghai Sea, China.

77. *Rullierinereis profunda* Imajima, 2009

Rullierinereis profunda Imajima, 2009: 85–88, Figs. 21A–E, 22A–M.

Distribution – Only known from type locality. Type locality: Honshu Is., Japan.

Genus *Simplisetia* Hartmann-Schröder, 1985

78. *Simplisetia erythraeensis* (Fauvel, 1918)

Ceratonereis erythraeensis Fauvel 1918: 407–410, Pl. XVI, figs. 26–30; Imajima and Hartman, 1964: 140; Imajima, 1972: 61–63, fig 12a–p; fig. 17; 1996: 120, fig. 95a–n; Paik, 1977: 165–167, fig. 13a–h; 1982: 785, fig. 12a–c; Wu et al., 1985: 177–178, fig. 100A–N; Paik, 1989: 301–303, pl. 22, 23, figs. 85a, b–1, 2, text fig. 68a–g.

Nereis (*Ceratonereis*) *erythraeensis*: Okuda, 1940, 9–12, text fig. 5; Khlebovich and Wu, 1962, 37, pl. 2, v–z.

Simplisetia erythraeensis: Sato, 2017: 483, table 19.1.

Distribution – China, Japan, Korea. Type locality: Percian Gulf.

Genus *Sinonereis* Wu and Sun, 1979

79. *Sinonereis heteropoda* Wu and Sun, 1979

Sinonereis heteropoda Wu and Sun, 1979: 95–99, figs. 1, 2; Wu et al., 1985: 52–54, fig. 26A–J, fig. 27A–D.

Distribution – China (Huanghai Sea, East China Sea, South China Sea). Type locality: Huanghai Sea, China.

Genus *Tylorrhynchus* Grube, 1866

80. *Tylorrhynchus heterochaetus* (Quatrefages, 1866)

Ceratocephale osawai Izuka, 1903: 1–37, 2 pls; Izuka, 1912: 179–181.

Tylorrhynchus heterochaetus: Imajima, 1972: 46–50, figs. 4a–k, 5a–c, 7; Paik, 1972: 128–131, fig. 1a–g; 1982: 782, pl.10n–p; Paik, 1989: 285–287, pl. 19, fig. 51(1–4), text fig. 61A–E.

Distribution – China, Japan, Korea. Type locality: Ceylon, Sri Lanka.

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요 약

동북아시아에 서식하는 참갯지렁이과 다모류에 대한 분류학적 연구를 수행하였다. 분류학 문헌에 기초하여 동북아시아 해역에서 기록된 총 105 공칭종(nominal species)의 목록을 만들고 생물지리학적 분포 범위 등을 토대로 분류학적 동정 오류가 의심되는 27 공칭종을 대상으로 분류학적 재검토를 실시하였다. 분류학적 재검토는 오동정이 의심되는 종의 표본을 해당 종의 모식표본과 모식산지 표본과의 형태 및 COI 분자형질을 비교하여 수행하였다.

연구 대상종 중 COI염기서열 확보가 가능했던 동북아시아산 22종의 분류학적 유효성을 살피기 위해 대조 분류군을 포함하여 참갯지렁이류 총 32종으로부터 얻은 234개체의 COI 염기서열을 'reverse taxonomy'방법을 이용하여 분석하였으며 그 결과 10 분류군(*Perinereis wilsoni* Glasby and Hsieh, 2006, *P. cultrifera* (Grube, 1840), *Pseudonereis variegata* (Grube, 1857), *Hediste japonica* (Izuka, 1908), *Nereis denhamensis* Augener, 1913, *N. vexillosa* Grube, 1851, *N. pelagica* Linnaeus, 1758, *N. multignatha* Imajima and Hartman, 1964, *Platynereis bicanaliculata* (Baird, 1863), *Cheilonereis cyclurus* (Harrington, 1897))으로 부터 미기재종 또는 오동정을 검출하였다. 검출된 종을 포함하여 27 공칭종에 대한 분류학적 재검토 결과 다음과 같은 결론을 얻었다. 1. COI 염기서열 비교분석결과 비교적 최근 형태형질을 이용한 분류학적 재검토가 수행된 *Hediste atoka* Sato and Nakashima, 2003; *H. diadroma* Sato and Nakashima, 2003; *Nectoneanthes oxypoda* (Marenzeller, 1879); *N. uchiwa* Sato, 2013; *N. heterocirrata* Treadwell, 1931; *N. tigrina* Zachs, 1933; *Perinereis aibuhitensis* (Geube, 1878); *P. linea* (Treadwell, 1936); *P. mictodonta* (Marenzeller, 1879); *P. shikueii* Glasby and Hsieh, 2006의 10종에 대한 종 동정의 확증. 2. 동북아시아에서 기록된 *Hediste japonica*, *Nereis multignatha*, *Perinereis wilsoni*, *Platynereis bicanaliculata*는 은둔종(cryptic species) 또는 종복합군(species complex)으로 구성되어 있다는 것과 이 중 *Nereis multignatha*에

포함되어 동정되어온 은둔종 1종에 대한 신종 기재. 3. 동북아시아에서 기록된 *Perinereis floridana* (Ehlers, 1868), *P. cultrifera*, *Nereis denhamensis*, *N. pelagica*, *N. vexillosa*, *N. neoneanthes* Hartman, 1948, *Pseudonereis variegata* 7종은 오동정 이며 *Perinereis floridana*와 *P. cultrifera*는 같은 종이고 *P. euiini* Park and Kim 2017의 신종으로, *Nereis denhamensis*, *N. vexillosa*, *Pseudonereis variegata*는 각각 *Nereis* sp. nov. 1, *N.* sp. nov. 4, *Pseudonereis* sp. nov.의 신종으로 동정됨. *Nereis neoneanthes*는 모식표본과는 다른 형태적 차이를 가지고 있었고 동북아시아가 모식산지인 *N. multignatha*와 같은 종으로 재동정 됨. *Nereis pelagica*로 기록되어온 종은 신종으로 재동정 되어야 하나 신종의 확증을 위해서는 태평양과 대서양 연안의 표본과 형태비교가 필요함. 4. 일본에서 신종으로 기록된 *Nereis shishidoi* Izuka, 1912는 *Cheilonereis cyclurus*의 Junior synonym으로 여겨져왔으나 한국과 일본 *N. shishidoi*의 모식산지 인근해역에서 채집된 *C. cyclurus*의 표본을 *C. cyclurus* 모식산지 표본과 비교한 결과 서로다른 차이를 보여 *Nereis shishidoi*를 적합명칭으로 되돌리고 *Cheilonereis*속으로 편입시킴. 5. *Nereis* (*Neanthes*) *orientalis* Treadwell, 1936는 *Perinereis aibuhitensis*로 동물이명 처리되었으나 모식표본 관찰결과 *P. linea*와 같은 종임을 밝히고 재동물이명 처리하였고, *Perinereis vancaurica tetradentata* Imajima, 1972의 모식표본 관찰결과 역시 *P. linea*와 같은 종으로 판명하고 동물이명 처리함. 6. 동북아시아에 기록된 *Alitta brandti* Malmgren, 1865와 *Pseudonereis anomala* Gravier, 1901는 형태변이가 심한 종으로 모식산지 문헌 또는 모식표본과 형태비교 결과 오동정으로 의심되나 재동정을 위해서는 염기서열 비교 등의 추가연구가 필요함.

또한 본 연구를 위한 표본확보 중 동해와 제주해역에서 두 종의 참갯지렁이류 신종후보종 표본이 채집되어 각각 *Nereis* sp. nov. 2와 *Composetia* sp. nov.로 기재하였다.

본 연구결과를 포함하여 동북아시아 해역에서 현재까지 기록된 105종의 공칭종 중 분류학적으로 유효한 80종에 대한 종목록을 처음으로 제시하였으며 이들 중 동북아시아 고유종은 51종으로 집계되었다.

Appendix 1. Pairwise genetic distance (K2P distance) matrix based on 658 positions of COI sequences. A total of 234 individuals from 42 nereidid species are applied (Table 1).

1. *Alitta virens* (1-1. Avirens1, 1-2. Avirens2, 1-3. Avirens3)
2. *Alitta* cf. *brandti* (2-1. NvMuk)
3. *Cheilonereis cyclurus* (3-1. Ccyclurus)
4. *Cheilonereis shishidoi* (4-1. CheGa1, 4-2. CheGa2, 4-3. CheGa3)
5. *Composetia* sp. nov. (5-1. Nji, 5-2. Nwul)
6. *Hediste atoka* (6-1. Hatoka, 6-2. Hjgeoje1, 6-3. Hjgeoje2, 6-4. Hjgeoje3, 6-5. Hjgeoje4, 6-6. Hjgeoje5, 6-7. Hjgeoje6, 6-8. Hjgeoje7, 6-9. Hjgeoje9, 6-10. Hjkpo1, 6-11. Hjkpo2, 6-12. Hjkpo3, 6-13. Hjkpo4, 6-14. Hjkpo5, 6-15. Hjnam1, 6-16. Hjnam2, 6-17. Hjnam3, 6-18. Hjnam4, 6-19. Hjnam5, 6-20. Hjosip1, 6-21. Hjosip2, 6-22. Hjosip3, 6-23. Hjosip4, 6-24. Hjosip6, 6-25. Hjosip8, 6-26. Hjosip9, 6-27. Hjosip10, 6-28. Hjsehwa2, 6-29. Hjsehwa3, 6-30. Hjsehwa4, 6-31. Hjsehwa8, 6-32. Hjsehwa9, 6-33. Hjwangpi1, 6-34. Hjwangpi2, 6-35. Hjwangpi3, 6-36. Hatoshin1, 6-37. Hatoshin2)
7. *Hediste diadroma* (7-1. Hdiadroma, 7-2. Hdiachil, 7-3. HdiaOmoi2. 7-4. Hdiasai, 7-5. Hjhach1, 7-6. Hjhach4, 7-7. Hjhach5, 7-8. Hjhach6)
8. *Hediste japonica* (8-1. Hjaponica, 8-2. HjAri1, 8-3. HjAri2, 8-4. HjAri3, 8-5. HjAri4, 8-6. HjYpis1, 8-7. HjYpis2, 8-8. HjDongmak1, 8-9. HjDongmak2, 8-10. HjDongmak3, 8-11. HjDongmak4)
9. *Hediste* sp. (9-1. HnGeom1, 9-2. HnGeom2, 9-3. HnGeom3, 9-4. Hjgeom1, 9-5. Hjgeom2, 9-6. HnGong1, 9-7. HnGong2, 9-8. HnGong3, 9-9. HjHannew)
10. *Nectoneanthes oxypoda* (10-1. NecoxyG1)
11. *Nectoneanthes uchiwa* (11-1. NecuM1, 11-2. NecuM2, 11-3. NecuM3)
12. *Nereis denhamensis* (12-1. Ndenhamensis)
13. *Nereis* sp. nov. 1 (13-1. NpWang1, 13-2. NpWang2, 13-3. NpWu, 13-4. NspGa, 13-5. NdenJ2)
14. *Nereis heterocirrata* (14-1. Nheterocirrata, 14-2. NhGwang1, 14-3. NhGwang2, 14-4. NhGwang3, 14-5. NhPohang1, 14-6. NspOng)
15. *Nereis* aff. *pelagica* (15-1. NpGo, 15-2. NpMun1)
16. *Nereis pelagica* (16-1. Npelagica1, 16-2. Npelagica2, 16-3. Npelagica3)
17. *Nereis* sp. nov. 2 (17-1. NspWang1, 17-2. NspWang2, 17-3. NspDDC)
18. *Nereis* sp. nov. 3 (18-1. NmulTy1, 18-2. NmulTy2, 18-3. NmulImpo, 18-4. NmulGeo, 18-5. NmulOi)
19. *Nereis multignatha* (19-1. NmulYang1, 19-2. NneoWang2, 19-3. NneoWang3, 19-4. NneoYeo1, 19-5. NneoYeo2, 19-6. NneoYeo4, 19-7. NneoYeo6)
20. *Nereis tigrina* (20-1. NeYa, 20-2. NspYang1, 20-3. NspOa, 20-4. NspYang, 20-5. NspYa1, 20-6. NspYa2, 20-7. NspYa3, 20-8. NezDong)
21. *Nereis vexillosa* (21-1. Nvexillosa1, 21-2. Nvexillosa2)
22. *Nereis* sp. nov. 4 (22-1. Nvexillosa3)
23. Nereis zonata (23-1. Nzonata1, 23-2. Nzonata2)

24. *Perinereis aibuhitensis* (24-1. PaPaM1, 24-2. PaPaM2, 24-3. PaPaM3)
25. *Perinereis euiini* (25-1. Pcultrifera1, 25-2. Pcultrifera2, 25-3. Pcultrifera3, 25-4. Pcgeoje1, 25-5. Pcgeoje2, 25-6. Pcgeoje3)
26. *Perinereis cultrifera* (26-1. Pcultrifera4, 26-2. Pcultrifera5, 26-3. Pcultrifera6)
27. *Perinereis linea* (27-1. PaJa1, 27-2. PaJa3, 27-3. PaJa4, 27-4. Pljeongok1, 27-5. Pljeongok2, 27-6. Pljeongok3)
28. *Perinereis mictodonta* (28-1. Pnbiin4, 28-2. Pnbiin6, 28-3. Pnbiin14, 28-4. Pnbiin17, 28-5. Pnbiin18, 28-6. Pnbiin22, 28-7. Pnbiin26, 28-8. Pnbiin28, 28-9. Pnbiin32, 28-10. PmicAria, 28-11. PmicSai, 28-12. PmicSai1, 28-13. PnYounp3, 28-14. PnYounp4, 28-15. PnYounp5, 28-16. PsJ1, 28-17. PsJ2, 28-18. PsJ3, 28-19. PsJ5, 28-20. PsJ6, 28-21. PsJ7, 28-22. PsJ8, 28-23. PsJ10)
29. *Perinereis rhombodonta* (29-1. Prhom1, 29-2. Prhom2, 29-3. Prhom3)
30. *Perinereis shikueii* (30-1. PmicNana, 30-2. PmNaka2, 30-3. PmNaka4, 30-4. PmNaka5)
31. *Perinereis singaporiensis* (31-1. PsiD1, 31-2. PsiD2, 31-3. PsiD3)
32. *Perinereis vallata* (32-1. Pval1, 32-2. Pval2)
33. *Perinereis wilsoni* complex (33-1. Pwilsoni1, 33-2. Pwilsoni2, 33-3. Pncnew1, 33-4. Pncnew2, 33-5. Pncnew3, 33-6. Pncnew4, 33-7. PnJh4, 33-8. PnJh6, 33-9. PnJh7, 33-10. PnJojo1, 33-11. PnJojo2, 33-12. PnJojo3, 33-13. PnJojo4, 33-14. PwilYul2, 33-15. PwilYul3, 33-16. PmSin1, 33-17. PmSin2, 33-18. Pnbiin2, 33-19. PnC9, 33-20. Pnepitoky, 33-21. PspHong1, 33-22. PspHong2, 33-23. PspHong5, 33-24. PspHong6, 33-25. PspHong8)
34. *Platynereis* sp. 2 (34-1. Pbicanaliculata1, 34-2. Pbicanaliculata3, 34-3. Pbicanaliculata6, 34-4. Pbicanaliculata7, 34-5. NspYung, 34-6. PlbSeo, 34-7. PlbYul, 34-8. PlbGa1, 34-9. PlbGa2, 34-10. PlbDok, 34-11. PlbOi1, 34-12. PlbOi2)
35. *Platynereis bicanaliculata* (35-1. Pbicanaliculata2, 35-2. Pbicanaliculata4, 35-3. Pbicanaliculata5)
36. *Platynereis* sp. 1 (36-1. PlatUl1, 36-2. PlatYeo1)
37. *Platynereis dumerilii* (37-1. Pdumerilii1, 37-2. Pdumerilii2)
38. *Pseudonereis anomala* (38-1. Panomala1)
39. *Pseudonereis gallapagensis* (39-1. Pgallapagensis)
40. *Pseudonereis* sp. nov. (40-1. PseudoAya, 40-2. PseudoHong, 40-3. PvJp1, 40-4. PvJp2, 40-5. PvPohang1, 40-6. PvPohang2, 40-7. PvUlsan2, 40-8. PvUlsan3)
41. *Pseudonereis variegate* (41-1. Pvariegata1)
42. *Pseudonereis* sp. nov. (42-1. Pvariegata2, 42-2. Pvariegata3)

Table 1. Pairwise genetic distance (K2P distance) matrix based on 658 positions of COI sequences. A total of 234 individuals from 42 nereidid species are applied.

	1-1	1-2	1-3	2-1	3-1	4-1	4-2	4-3	5-1	5-2	6-1	6-2	6-3	6-4	6-5	6-6	6-7	6-8	6-9	6-10	6-11	6-12	6-13	6-14	6-15	6-16	6-17	6-18	6-19	6-20	6-21	6-22	6-23	6-24
1-1																																		
1-2	0.000																																	
1-3	0.000	0.000																																
2-1	0.155	0.155	0.155																															
3-1	0.258	0.258	0.258	0.221																														
4-1	0.249	0.249	0.249	0.263	0.173																													
4-2	0.249	0.249	0.249	0.263	0.173	0.008																												
4-3	0.249	0.249	0.249	0.263	0.173	0.008	0.000																											
5-1	0.253	0.253	0.253	0.237	0.230	0.240	0.240	0.240																										
5-2	0.233	0.233	0.233	0.233	0.238	0.240	0.240	0.240	0.017																									
6-1	0.238	0.238	0.238	0.219	0.236	0.257	0.249	0.249	0.223	0.231																								
6-2	0.230	0.230	0.230	0.219	0.236	0.261	0.253	0.253	0.226	0.234	0.025																							
6-3	0.226	0.226	0.226	0.219	0.244	0.261	0.253	0.253	0.230	0.238	0.025	0.017																						
6-4	0.230	0.230	0.230	0.219	0.236	0.261	0.253	0.253	0.226	0.234	0.025	0.000	0.017																					
6-5	0.230	0.230	0.230	0.219	0.236	0.261	0.253	0.253	0.226	0.234	0.025	0.000	0.017	0.000																				
6-6	0.226	0.226	0.226	0.219	0.244	0.261	0.253	0.253	0.230	0.238	0.025	0.017	0.000	0.017	0.017																			
6-7	0.230	0.230	0.230	0.219	0.236	0.261	0.253	0.253	0.226	0.234	0.025	0.000	0.017	0.000	0.000	0.017																		
6-8	0.230	0.230	0.230	0.219	0.236	0.261	0.253	0.253	0.226	0.234	0.025	0.000	0.017	0.000	0.000	0.017	0.000																	
6-9	0.230	0.230	0.230	0.223	0.248	0.265	0.257	0.257	0.234	0.242	0.028	0.019	0.003	0.019	0.019	0.003	0.019	0.019																
6-10	0.230	0.230	0.230	0.223	0.248	0.261	0.253	0.253	0.234	0.242	0.028	0.019	0.003	0.019	0.019	0.003	0.019	0.019	0.005															
6-11	0.230	0.230	0.230	0.223	0.248	0.261	0.253	0.253	0.234	0.242	0.028	0.019	0.003	0.019	0.019	0.003	0.019	0.019	0.005	0.000														
6-12	0.226	0.226	0.226	0.219	0.244	0.261	0.253	0.253	0.230	0.238	0.025	0.017	0.000	0.017	0.017	0.000	0.017	0.017	0.003	0.003	0.003													
6-13	0.230	0.230	0.230	0.215	0.240	0.257	0.249	0.249	0.226	0.234	0.028	0.019	0.003	0.019	0.019	0.003	0.019	0.019	0.005	0.005	0.005	0.003												
6-14	0.230	0.230	0.230	0.215	0.240	0.257	0.249	0.249	0.226	0.234	0.022	0.014	0.003	0.014	0.014	0.003	0.014	0.014	0.005	0.005	0.005	0.003	0.005											
6-15	0.223	0.223	0.223	0.223	0.232	0.261	0.253	0.253	0.226	0.219	0.031	0.028	0.034	0.028	0.028	0.034	0.028	0.028	0.037	0.037	0.037	0.034	0.037	0.031										
6-16	0.223	0.223	0.223	0.223	0.232	0.261	0.253	0.253	0.226	0.219	0.031	0.028	0.034	0.028	0.028	0.034	0.028	0.028	0.037	0.037	0.037	0.034	0.037	0.031	0.000									
6-17	0.223	0.223	0.223	0.223	0.232	0.261	0.253	0.253	0.226	0.219	0.031	0.028	0.034	0.028	0.028	0.034	0.028	0.028	0.037	0.037	0.037	0.034	0.037	0.031	0.000	0.000								
6-18	0.223	0.223	0.223	0.223	0.232	0.261	0.253	0.253	0.226	0.219	0.031	0.028	0.034	0.028	0.028	0.034	0.028	0.028	0.037	0.037	0.037	0.034	0.037	0.031	0.000	0.000	0.000							
6-19	0.223	0.223	0.223	0.223	0.232	0.261	0.253	0.253	0.226	0.219	0.031	0.028	0.034	0.028	0.028	0.034	0.028	0.028	0.037	0.037	0.037	0.034	0.037	0.031	0.000	0.000	0.000	0.000						
6-20	0.234	0.234	0.234	0.219	0.244	0.257	0.249	0.249	0.230	0.238	0.025	0.017	0.005	0.017	0.017	0.005	0.017	0.017	0.008	0.003	0.003	0.005	0.008	0.003	0.034	0.034	0.034	0.034	0.034					
6-21	0.230	0.230	0.230	0.223	0.248	0.261	0.253	0.253	0.234	0.242	0.028	0.019	0.003	0.019	0.019	0.003	0.019	0.019	0.005	0.000	0.000	0.003	0.005	0.005	0.037	0.037	0.037	0.037	0.037	0.003				
6-22	0.234	0.234	0.234	0.219	0.244	0.257	0.249	0.249	0.230	0.238	0.025	0.017	0.005	0.017	0.017	0.005	0.017	0.017	0.008	0.003	0.003	0.005	0.008	0.003	0.034	0.034	0.034	0.034	0.034	0.000	0.003			
6-23	0.226	0.226	0.226	0.219	0.244	0.261	0.253	0.253	0.230	0.238	0.025	0.017	0.000	0.017	0.017	0.000	0.017	0.017	0.003	0.003	0.003	0.000	0.003	0.003	0.034	0.034	0.034	0.034	0.034	0.005	0.003	0.005		
6-24	0.234	0.234	0.234	0.219	0.244	0.257	0.249	0.249	0.230	0.238	0.025	0.017	0.005	0.017	0.017	0.005	0.017	0.017	0.008	0.003	0.003	0.005	0.008	0.003	0.034	0.034	0.034	0.034	0.034	0.000	0.003	0.000	0.005	

Table 1. Continued.

	1-1	1-2	1-3	2-1	3-1	4-1	4-2	4-3	5-1	5-2	6-1	6-2	6-3	6-4	6-5	6-6	6-7	6-8	6-9	6-10	6-11	6-12	6-13	6-14	6-15	6-16	6-17	6-18	6-19	6-20	6-21	6-22	6-23	6-24
6-25	0.234	0.234	0.234	0.219	0.244	0.257	0.249	0.249	0.230	0.238	0.025	0.017	0.005	0.017	0.017	0.005	0.017	0.017	0.008	0.003	0.003	0.005	0.008	0.003	0.034	0.034	0.034	0.034	0.034	0.000	0.003	0.000	0.005	0.000
6-26	0.234	0.234	0.234	0.219	0.244	0.257	0.249	0.249	0.230	0.238	0.025	0.017	0.005	0.017	0.017	0.005	0.017	0.017	0.008	0.003	0.003	0.005	0.008	0.003	0.034	0.034	0.034	0.034	0.034	0.000	0.003	0.000	0.005	0.000
6-27	0.230	0.230	0.230	0.223	0.244	0.261	0.253	0.253	0.226	0.234	0.028	0.019	0.003	0.019	0.019	0.003	0.019	0.019	0.005	0.005	0.005	0.003	0.005	0.005	0.031	0.031	0.031	0.031	0.031	0.008	0.005	0.008	0.003	0.008
6-28	0.230	0.230	0.230	0.219	0.236	0.261	0.253	0.253	0.226	0.234	0.025	0.000	0.017	0.000	0.000	0.017	0.000	0.000	0.019	0.019	0.019	0.017	0.019	0.014	0.028	0.028	0.028	0.028	0.028	0.017	0.019	0.017	0.017	0.017
6-29	0.234	0.234	0.234	0.223	0.240	0.265	0.257	0.257	0.230	0.238	0.028	0.003	0.019	0.003	0.003	0.019	0.003	0.003	0.022	0.022	0.022	0.019	0.022	0.017	0.031	0.031	0.031	0.031	0.031	0.019	0.022	0.019	0.019	0.019
6-30	0.230	0.230	0.230	0.219	0.236	0.261	0.253	0.253	0.226	0.234	0.025	0.000	0.017	0.000	0.000	0.017	0.000	0.000	0.019	0.019	0.019	0.017	0.019	0.014	0.028	0.028	0.028	0.028	0.028	0.017	0.019	0.017	0.017	0.017
6-31	0.230	0.230	0.230	0.219	0.236	0.261	0.253	0.253	0.226	0.234	0.025	0.000	0.017	0.000	0.000	0.017	0.000	0.000	0.019	0.019	0.019	0.017	0.019	0.014	0.028	0.028	0.028	0.028	0.028	0.017	0.019	0.017	0.017	0.017
6-32	0.230	0.230	0.230	0.219	0.236	0.261	0.253	0.253	0.226	0.234	0.025	0.000	0.017	0.000	0.000	0.017	0.000	0.000	0.019	0.019	0.019	0.017	0.019	0.014	0.028	0.028	0.028	0.028	0.028	0.017	0.019	0.017	0.017	0.017
6-33	0.234	0.234	0.234	0.219	0.244	0.257	0.249	0.249	0.230	0.238	0.025	0.017	0.005	0.017	0.017	0.005	0.017	0.017	0.008	0.003	0.003	0.005	0.008	0.003	0.034	0.034	0.034	0.034	0.034	0.000	0.003	0.000	0.005	0.000
6-34	0.234	0.234	0.234	0.219	0.244	0.253	0.245	0.245	0.230	0.238	0.025	0.017	0.005	0.017	0.017	0.005	0.017	0.017	0.008	0.008	0.008	0.005	0.008	0.003	0.034	0.034	0.034	0.034	0.034	0.005	0.008	0.005	0.005	0.005
6-35	0.238	0.238	0.238	0.223	0.248	0.257	0.249	0.249	0.234	0.242	0.028	0.019	0.008	0.019	0.019	0.008	0.019	0.019	0.011	0.005	0.005	0.008	0.011	0.005	0.037	0.037	0.037	0.037	0.037	0.003	0.005	0.003	0.008	0.003
6-36	0.242	0.242	0.242	0.223	0.240	0.257	0.249	0.249	0.227	0.235	0.003	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.031	0.025	0.025	0.028	0.031	0.025	0.034	0.034	0.034	0.034	0.034	0.022	0.025	0.022	0.028	0.022
6-37	0.246	0.246	0.246	0.227	0.240	0.257	0.249	0.249	0.223	0.231	0.005	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.034	0.028	0.028	0.031	0.034	0.028	0.031	0.031	0.031	0.031	0.031	0.025	0.028	0.025	0.031	0.025
7-1	0.235	0.235	0.235	0.200	0.222	0.283	0.283	0.283	0.226	0.242	0.132	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.142	0.142	0.142	0.138	0.135	0.142	0.125	0.125	0.125	0.125	0.125	0.145	0.142	0.145	0.138	0.145
7-2	0.243	0.243	0.243	0.200	0.214	0.270	0.283	0.283	0.234	0.250	0.138	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.148	0.145	0.145	0.145	0.141	0.148	0.125	0.125	0.125	0.125	0.125	0.148	0.145	0.148	0.145	0.148
7-3	0.235	0.235	0.235	0.200	0.211	0.278	0.278	0.278	0.226	0.242	0.139	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.149	0.149	0.149	0.145	0.142	0.149	0.132	0.132	0.132	0.132	0.132	0.152	0.149	0.152	0.145	0.152
7-4	0.243	0.243	0.243	0.200	0.215	0.278	0.278	0.278	0.234	0.250	0.132	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.142	0.142	0.142	0.138	0.135	0.142	0.118	0.118	0.118	0.118	0.118	0.145	0.142	0.145	0.138	0.145
7-5	0.231	0.231	0.231	0.196	0.207	0.262	0.270	0.270	0.219	0.234	0.132	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.142	0.142	0.142	0.138	0.135	0.142	0.118	0.118	0.118	0.118	0.118	0.145	0.142	0.145	0.138	0.145
7-6	0.240	0.240	0.240	0.197	0.215	0.283	0.283	0.283	0.238	0.254	0.135	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.142	0.142	0.142	0.138	0.135	0.142	0.118	0.118	0.118	0.118	0.118	0.145	0.142	0.145	0.138	0.145
7-7	0.239	0.239	0.239	0.196	0.215	0.274	0.274	0.274	0.222	0.238	0.135	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.145	0.145	0.145	0.142	0.138	0.145	0.128	0.128	0.128	0.128	0.128	0.149	0.145	0.149	0.142	0.149
7-8	0.240	0.240	0.240	0.197	0.215	0.283	0.283	0.283	0.238	0.254	0.135	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.142	0.142	0.142	0.138	0.135	0.142	0.118	0.118	0.118	0.118	0.118	0.145	0.142	0.145	0.138	0.145
8-1	0.249	0.249	0.249	0.229	0.206	0.228	0.225	0.225	0.239	0.243	0.172	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.169	0.166	0.166	0.166	0.169	0.162	0.165	0.165	0.165	0.165	0.165	0.162	0.166	0.162	0.166	0.162
8-2	0.245	0.245	0.245	0.229	0.214	0.236	0.232	0.232	0.243	0.247	0.172	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.169	0.166	0.166	0.166	0.169	0.162	0.165	0.165	0.165	0.165	0.165	0.162	0.166	0.162	0.166	0.162
8-3	0.249	0.249	0.249	0.229	0.206	0.228	0.225	0.225	0.239	0.243	0.172	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.169	0.166	0.166	0.166	0.169	0.162	0.165	0.165	0.165	0.165	0.165	0.162	0.166	0.162	0.166	0.162
8-4	0.249	0.249	0.249	0.229	0.206	0.228	0.225	0.225	0.239	0.243	0.172	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.169	0.166	0.166	0.166	0.169	0.162	0.165	0.165	0.165	0.165	0.165	0.162	0.166	0.162	0.166	0.162
8-5	0.245	0.245	0.245	0.225	0.210	0.225	0.221	0.221	0.235	0.239	0.169	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.166	0.162	0.162	0.162	0.166	0.159	0.162	0.162	0.162	0.162	0.162	0.159	0.162	0.159	0.162	0.159
8-6	0.256	0.256	0.256	0.225	0.213	0.236	0.232	0.232	0.239	0.251	0.176	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.173	0.169	0.169	0.169	0.173	0.165	0.169	0.169	0.169	0.169	0.169	0.165	0.169	0.165	0.169	0.165
8-7	0.256	0.256	0.256	0.225	0.213	0.236	0.232	0.232	0.239	0.251	0.176	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.173	0.169	0.169	0.169	0.173	0.165	0.169	0.169	0.169	0.169	0.169	0.165	0.169	0.165	0.169	0.165
8-8	0.245	0.245	0.245	0.233	0.210	0.232	0.228	0.228	0.247	0.251	0.176	0.169	0.162	0.169	0.169	0.162	0.169	0.169	0.166	0.162	0.162	0.162	0.166	0.166	0.169	0.169	0.169	0.169	0.169	0.166	0.162	0.166	0.162	0.166
8-9	0.249	0.249	0.249	0.229	0.206	0.228	0.225	0.225	0.243	0.247	0.172	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.169	0.166	0.166	0.166	0.169	0.162	0.165	0.165	0.165	0.165	0.165	0.162	0.166	0.162	0.166	0.162
8-10	0.249	0.249	0.249	0.229	0.206	0.228	0.225	0.225	0.239	0.243	0.172	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.169	0.166	0.166	0.166	0.169	0.162	0.165	0.165	0.165	0.165	0.165	0.162	0.166	0.162	0.166	0.162
8-11	0.249	0.249	0.249	0.229	0.206	0.228	0.225	0.225	0.239	0.243	0.176	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.173	0.169	0.169	0.169	0.173	0.166	0.169	0.169	0.169	0.169	0.169	0.166	0.169	0.166	0.169	0.166
9-1	0.263	0.263	0.263	0.230	0.244	0.255	0.264	0.264	0.219	0.219	0.125	0.125	0.118	0.125	0.125	0.118	0.125	0.125	0.121	0.121	0.121	0.118	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.125	0.121	0.125	0.118	0.125
9-2	0.263	0.263	0.263	0.230	0.244	0.255	0.264	0.264	0.219	0.219	0.125	0.125	0.118	0.125	0.125	0.118	0.125	0.125	0.121	0.121	0.121	0.118	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.125	0.121	0.125	0.118	0.125

Table 1. Continued.

	6-25	6-26	6-27	6-28	6-29	6-30	6-31	6-32	6-33	6-34	6-35	6-36	6-37	7-1	7-2	7-3	7-4	7-5	7-6	7-7	7-8	8-1	8-2	8-3	8-4	8-5	8-6	8-7	8-8	8-9	8-10	8-11	9-1	9-2
6-25																																		
6-26	0.000																																	
6-27	0.008	0.008																																
6-28	0.017	0.017	0.019																															
6-29	0.019	0.019	0.022	0.003																														
6-30	0.017	0.017	0.019	0.000	0.003																													
6-31	0.017	0.017	0.019	0.000	0.003	0.000																												
6-32	0.017	0.017	0.019	0.000	0.003	0.000	0.000																											
6-33	0.000	0.000	0.008	0.017	0.019	0.017	0.017	0.017																										
6-34	0.005	0.005	0.008	0.017	0.019	0.017	0.017	0.017	0.005																									
6-35	0.003	0.003	0.011	0.019	0.022	0.019	0.019	0.019	0.003	0.008																								
6-36	0.022	0.022	0.031	0.028	0.031	0.028	0.028	0.028	0.022	0.028	0.025																							
6-37	0.025	0.025	0.028	0.031	0.034	0.031	0.031	0.031	0.025	0.031	0.028	0.003																						
7-1	0.145	0.145	0.135	0.138	0.142	0.138	0.138	0.138	0.145	0.145	0.149	0.135	0.132																					
7-2	0.148	0.148	0.141	0.145	0.148	0.145	0.145	0.145	0.148	0.152	0.152	0.138	0.135	0.019																				
7-3	0.152	0.152	0.142	0.145	0.149	0.145	0.145	0.145	0.152	0.152	0.156	0.142	0.139	0.011	0.025																			
7-4	0.145	0.145	0.135	0.138	0.142	0.138	0.138	0.138	0.145	0.145	0.149	0.135	0.132	0.014	0.005	0.019																		
7-5	0.145	0.145	0.135	0.138	0.142	0.138	0.138	0.138	0.145	0.145	0.149	0.135	0.132	0.014	0.011	0.019	0.011																	
7-6	0.145	0.145	0.135	0.138	0.142	0.138	0.138	0.138	0.145	0.145	0.149	0.139	0.135	0.014	0.011	0.019	0.005	0.017																
7-7	0.149	0.149	0.138	0.142	0.145	0.142	0.142	0.142	0.149	0.149	0.152	0.139	0.135	0.008	0.022	0.003	0.017	0.017	0.017															
7-8	0.145	0.145	0.135	0.138	0.142	0.138	0.138	0.138	0.145	0.145	0.149	0.139	0.135	0.014	0.011	0.019	0.005	0.017	0.000	0.017														
8-1	0.162	0.162	0.162	0.166	0.169	0.166	0.166	0.166	0.162	0.159	0.166	0.172	0.169	0.171	0.160	0.174	0.163	0.156	0.167	0.171	0.167													
8-2	0.162	0.162	0.162	0.166	0.169	0.166	0.166	0.166	0.162	0.159	0.166	0.172	0.169	0.171	0.167	0.182	0.171	0.163	0.170	0.178	0.170	0.011												
8-3	0.162	0.162	0.162	0.166	0.169	0.166	0.166	0.166	0.162	0.159	0.166	0.172	0.169	0.171	0.160	0.174	0.163	0.156	0.167	0.171	0.167	0.000	0.011											
8-4	0.162	0.162	0.162	0.166	0.169	0.166	0.166	0.166	0.162	0.159	0.166	0.172	0.169	0.171	0.160	0.174	0.163	0.156	0.167	0.171	0.167	0.000	0.011	0.000										
8-5	0.159	0.159	0.159	0.162	0.166	0.162	0.162	0.162	0.159	0.155	0.162	0.169	0.165	0.167	0.157	0.171	0.160	0.153	0.163	0.167	0.163	0.003	0.014	0.003	0.003									
8-6	0.165	0.165	0.165	0.169	0.173	0.169	0.169	0.169	0.165	0.162	0.169	0.176	0.172	0.181	0.171	0.185	0.174	0.167	0.174	0.181	0.174	0.011	0.011	0.011	0.011	0.014								
8-7	0.165	0.165	0.165	0.169	0.173	0.169	0.169	0.169	0.165	0.162	0.169	0.176	0.172	0.181	0.171	0.185	0.174	0.167	0.174	0.181	0.174	0.011	0.011	0.011	0.011	0.014	0.000							
8-8	0.166	0.166	0.159	0.169	0.173	0.169	0.169	0.169	0.166	0.162	0.169	0.176	0.172	0.171	0.160	0.174	0.163	0.156	0.163	0.171	0.163	0.005	0.011	0.005	0.005	0.008	0.011	0.011						
8-9	0.162	0.162	0.162	0.166	0.169	0.166	0.166	0.166	0.162	0.159	0.166	0.172	0.169	0.174	0.164	0.178	0.167	0.160	0.167	0.174	0.167	0.003	0.008	0.003	0.003	0.005	0.008	0.008	0.003					
8-10	0.162	0.162	0.162	0.166	0.169	0.166	0.166	0.166	0.162	0.159	0.166	0.172	0.169	0.171	0.160	0.174	0.163	0.156	0.167	0.171	0.167	0.000	0.011	0.000	0.000	0.003	0.011	0.011	0.005	0.003				
8-11	0.166	0.166	0.166	0.169	0.173	0.169	0.169	0.169	0.166	0.162	0.169	0.176	0.172	0.174	0.164	0.178	0.167	0.160	0.167	0.174	0.167	0.005	0.011	0.005	0.005	0.008	0.011	0.011	0.005	0.003	0.005			
9-1	0.125	0.125	0.121	0.125	0.128	0.125	0.125	0.125	0.125	0.125	0.125	0.128	0.131	0.158	0.151	0.161	0.151	0.148	0.151	0.158	0.151	0.194	0.197	0.194	0.194	0.190	0.193	0.193	0.190	0.194	0.194	0.194		
9-2	0.125	0.125	0.121	0.125	0.128	0.125	0.125	0.125	0.125	0.125	0.125	0.128	0.131	0.158	0.151	0.161	0.151	0.148	0.151	0.158	0.151	0.194	0.197	0.194	0.194	0.190	0.193	0.193	0.190	0.194	0.194	0.194	0.000	

Table 1. Continued.

	1-1	1-2	1-3	2-1	3-1	4-1	4-2	4-3	5-1	5-2	6-1	6-2	6-3	6-4	6-5	6-6	6-7	6-8	6-9	6-10	6-11	6-12	6-13	6-14	6-15	6-16	6-17	6-18	6-19	6-20	6-21	6-22	6-23	6-24
9-3	0.263	0.263	0.263	0.230	0.244	0.255	0.264	0.264	0.219	0.219	0.125	0.125	0.118	0.125	0.125	0.118	0.125	0.125	0.121	0.121	0.121	0.118	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.125	0.121	0.125	0.118	0.125
9-4	0.263	0.263	0.263	0.230	0.244	0.255	0.264	0.264	0.219	0.219	0.125	0.125	0.118	0.125	0.125	0.118	0.125	0.125	0.121	0.121	0.121	0.118	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.125	0.121	0.125	0.118	0.125
9-5	0.263	0.263	0.263	0.230	0.244	0.255	0.264	0.264	0.219	0.219	0.125	0.125	0.118	0.125	0.125	0.118	0.125	0.125	0.121	0.121	0.121	0.118	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.125	0.121	0.125	0.118	0.125
9-6	0.263	0.263	0.263	0.230	0.244	0.255	0.264	0.264	0.219	0.219	0.125	0.125	0.118	0.125	0.125	0.118	0.125	0.125	0.121	0.121	0.121	0.118	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.125	0.121	0.125	0.118	0.125
9-7	0.263	0.263	0.263	0.230	0.244	0.255	0.264	0.264	0.219	0.219	0.125	0.125	0.118	0.125	0.125	0.118	0.125	0.125	0.121	0.121	0.121	0.118	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.125	0.121	0.125	0.118	0.125
9-8	0.263	0.263	0.263	0.230	0.244	0.255	0.264	0.264	0.219	0.219	0.125	0.125	0.118	0.125	0.125	0.118	0.125	0.125	0.121	0.121	0.121	0.118	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.125	0.121	0.125	0.118	0.125
9-9	0.263	0.263	0.263	0.230	0.244	0.255	0.264	0.264	0.219	0.219	0.125	0.125	0.118	0.125	0.125	0.118	0.125	0.125	0.121	0.121	0.121	0.118	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.125	0.121	0.125	0.118	0.125
10-1	0.234	0.234	0.234	0.214	0.236	0.229	0.229	0.229	0.205	0.216	0.206	0.218	0.214	0.218	0.218	0.214	0.218	0.218	0.218	0.218	0.218	0.214	0.218	0.210	0.218	0.218	0.218	0.218	0.218	0.214	0.218	0.214	0.214	0.214
11-1	0.246	0.246	0.246	0.233	0.232	0.229	0.218	0.218	0.198	0.187	0.221	0.225	0.217	0.225	0.225	0.217	0.225	0.225	0.221	0.217	0.217	0.217	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.217	0.221	0.217	0.221
11-2	0.246	0.246	0.246	0.233	0.232	0.229	0.218	0.218	0.198	0.187	0.221	0.225	0.217	0.225	0.225	0.217	0.225	0.225	0.221	0.217	0.217	0.217	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.217	0.221	0.217	0.221
11-3	0.246	0.246	0.246	0.233	0.232	0.229	0.218	0.218	0.198	0.187	0.221	0.225	0.217	0.225	0.225	0.217	0.225	0.225	0.221	0.217	0.217	0.217	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.217	0.221	0.217	0.221
12-1	0.299	0.299	0.299	0.241	0.217	0.229	0.229	0.229	0.241	0.245	0.215	0.204	0.204	0.204	0.204	0.204	0.204	0.204	0.200	0.207	0.207	0.204	0.207	0.204	0.215	0.215	0.215	0.215	0.215	0.207	0.207	0.207	0.204	0.207
13-1	0.268	0.268	0.268	0.267	0.207	0.231	0.239	0.239	0.192	0.199	0.267	0.275	0.283	0.275	0.275	0.283	0.275	0.275	0.288	0.288	0.288	0.283	0.288	0.279	0.271	0.271	0.271	0.271	0.271	0.283	0.288	0.283	0.283	0.283
13-2	0.268	0.268	0.268	0.267	0.207	0.231	0.239	0.239	0.192	0.199	0.267	0.275	0.283	0.275	0.275	0.283	0.275	0.275	0.288	0.288	0.288	0.283	0.288	0.279	0.271	0.271	0.271	0.271	0.271	0.283	0.288	0.283	0.283	0.283
13-3	0.268	0.268	0.268	0.267	0.207	0.231	0.239	0.239	0.192	0.199	0.267	0.275	0.283	0.275	0.275	0.283	0.275	0.275	0.288	0.288	0.288	0.283	0.288	0.279	0.271	0.271	0.271	0.271	0.271	0.283	0.288	0.283	0.283	0.283
13-4	0.268	0.268	0.268	0.267	0.207	0.231	0.239	0.239	0.192	0.199	0.267	0.275	0.283	0.275	0.275	0.283	0.275	0.275	0.288	0.288	0.288	0.283	0.288	0.279	0.271	0.271	0.271	0.271	0.271	0.283	0.288	0.283	0.283	0.283
13-5	0.264	0.264	0.264	0.263	0.211	0.235	0.243	0.243	0.188	0.196	0.263	0.271	0.279	0.271	0.271	0.279	0.271	0.271	0.283	0.283	0.283	0.279	0.283	0.275	0.267	0.267	0.267	0.267	0.267	0.279	0.283	0.279	0.279	0.279
14-1	0.260	0.260	0.260	0.267	0.248	0.260	0.256	0.256	0.284	0.271	0.309	0.296	0.309	0.296	0.296	0.309	0.296	0.296	0.314	0.309	0.309	0.309	0.314	0.305	0.296	0.296	0.296	0.296	0.296	0.305	0.309	0.305	0.309	0.305
14-2	0.256	0.256	0.256	0.263	0.244	0.256	0.252	0.252	0.284	0.271	0.309	0.296	0.309	0.296	0.296	0.309	0.296	0.296	0.314	0.309	0.309	0.309	0.314	0.305	0.296	0.296	0.296	0.296	0.296	0.305	0.309	0.305	0.309	0.305
14-3	0.256	0.256	0.256	0.263	0.244	0.256	0.252	0.252	0.284	0.271	0.309	0.296	0.309	0.296	0.296	0.309	0.296	0.296	0.314	0.309	0.309	0.309	0.314	0.305	0.296	0.296	0.296	0.296	0.296	0.305	0.309	0.305	0.309	0.305
14-4	0.256	0.256	0.256	0.263	0.244	0.256	0.252	0.252	0.284	0.271	0.309	0.296	0.309	0.296	0.296	0.309	0.296	0.296	0.314	0.309	0.309	0.309	0.314	0.305	0.296	0.296	0.296	0.296	0.296	0.305	0.309	0.305	0.309	0.305
14-5	0.256	0.256	0.256	0.263	0.244	0.256	0.252	0.252	0.284	0.271	0.309	0.296	0.309	0.296	0.296	0.309	0.296	0.296	0.314	0.309	0.309	0.309	0.314	0.305	0.296	0.296	0.296	0.296	0.296	0.305	0.309	0.305	0.309	0.305
14-6	0.256	0.256	0.256	0.263	0.244	0.256	0.252	0.252	0.284	0.271	0.309	0.296	0.309	0.296	0.296	0.309	0.296	0.296	0.314	0.309	0.309	0.309	0.314	0.305	0.296	0.296	0.296	0.296	0.296	0.305	0.309	0.305	0.309	0.305
15-1	0.236	0.236	0.236	0.256	0.216	0.194	0.198	0.198	0.259	0.259	0.284	0.288	0.276	0.288	0.288	0.276	0.288	0.288	0.280	0.276	0.276	0.276	0.271	0.280	0.284	0.284	0.284	0.284	0.284	0.280	0.276	0.280	0.276	0.280
15-2	0.236	0.236	0.236	0.256	0.216	0.194	0.198	0.198	0.259	0.259	0.284	0.288	0.276	0.288	0.288	0.276	0.288	0.288	0.280	0.276	0.276	0.276	0.271	0.280	0.284	0.284	0.284	0.284	0.284	0.280	0.276	0.280	0.276	0.280
16-1	0.244	0.244	0.244	0.244	0.176	0.165	0.165	0.165	0.224	0.240	0.256	0.244	0.260	0.244	0.244	0.260	0.244	0.244	0.264	0.264	0.264	0.260	0.256	0.256	0.244	0.244	0.244	0.244	0.244	0.260	0.264	0.260	0.260	0.260
16-2	0.236	0.236	0.236	0.228	0.180	0.172	0.172	0.172	0.228	0.236	0.256	0.252	0.260	0.252	0.252	0.260	0.252	0.252	0.264	0.264	0.264	0.260	0.256	0.256	0.252	0.252	0.252	0.252	0.252	0.260	0.264	0.260	0.260	0.260
16-3	0.244	0.244	0.244	0.252	0.184	0.165	0.158	0.158	0.224	0.240	0.248	0.236	0.252	0.236	0.236	0.252	0.236	0.236	0.256	0.256	0.256	0.252	0.248	0.248	0.236	0.236	0.236	0.236	0.236	0.252	0.256	0.252	0.252	0.252
17-1	0.238	0.238	0.238	0.214	0.198	0.190	0.186	0.186	0.235	0.239	0.233	0.229	0.237	0.229	0.229	0.237	0.229	0.229	0.233	0.237	0.237	0.237	0.241	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.237	0.233	0.237	0.233
17-2	0.238	0.238	0.238	0.214	0.198	0.190	0.186	0.186	0.235	0.239	0.233	0.229	0.237	0.229	0.229	0.237	0.229	0.229	0.233	0.237	0.237	0.237	0.241	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.237	0.233	0.237	0.233
17-3	0.234	0.234	0.234	0.214	0.194	0.190	0.186	0.186	0.227	0.231	0.225	0.222	0.229	0.222	0.222	0.229	0.222	0.222	0.225	0.229	0.229	0.229	0.233	0.225	0.225	0.225	0.225	0.225	0.225	0.225	0.229	0.225	0.229	0.225
18-1	0.243	0.243	0.243	0.217	0.216	0.215	0.211	0.211	0.242	0.238	0.258	0.254	0.254	0.254	0.254	0.254	0.254	0.254	0.258	0.254	0.254	0.254	0.258	0.250	0.270	0.270	0.270	0.270	0.270	0.250	0.254	0.250	0.254	0.250
18-2	0.243	0.243	0.243	0.217	0.216	0.215	0.211	0.211	0.242	0.238	0.258	0.254	0.254	0.254	0.254	0.254	0.254	0.254	0.258	0.254	0.254	0.254	0.258	0.250	0.270	0.270	0.270	0.270	0.270	0.250	0.254	0.250	0.254	0.250
18-3	0.243	0.243	0.243	0.216	0.219	0.215	0.211	0.211	0.242	0.238	0.257	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.257	0.253	0.253	0.253	0.257	0.249	0.269	0.269	0.269	0.269	0.269	0.249	0.253	0.249	0.253	0.249

Table 1. Continued.

	6-25	6-26	6-27	6-28	6-29	6-30	6-31	6-32	6-33	6-34	6-35	6-36	6-37	7-1	7-2	7-3	7-4	7-5	7-6	7-7	7-8	8-1	8-2	8-3	8-4	8-5	8-6	8-7	8-8	8-9	8-10	8-11	9-1	9-2
9-3	0.125	0.125	0.121	0.125	0.128	0.125	0.125	0.125	0.125	0.125	0.125	0.128	0.131	0.158	0.151	0.161	0.151	0.148	0.151	0.158	0.151	0.194	0.197	0.194	0.194	0.190	0.193	0.193	0.190	0.194	0.194	0.194	0.000	0.000
9-4	0.125	0.125	0.121	0.125	0.128	0.125	0.125	0.125	0.125	0.125	0.125	0.128	0.131	0.158	0.151	0.161	0.151	0.148	0.151	0.158	0.151	0.194	0.197	0.194	0.194	0.190	0.193	0.193	0.190	0.194	0.194	0.194	0.000	0.000
9-5	0.125	0.125	0.121	0.125	0.128	0.125	0.125	0.125	0.125	0.125	0.125	0.128	0.131	0.158	0.151	0.161	0.151	0.148	0.151	0.158	0.151	0.194	0.197	0.194	0.194	0.190	0.193	0.193	0.190	0.194	0.194	0.194	0.000	0.000
9-6	0.125	0.125	0.121	0.125	0.128	0.125	0.125	0.125	0.125	0.125	0.125	0.128	0.131	0.158	0.151	0.161	0.151	0.148	0.151	0.158	0.151	0.194	0.197	0.194	0.194	0.190	0.193	0.193	0.190	0.194	0.194	0.194	0.000	0.000
9-7	0.125	0.125	0.121	0.125	0.128	0.125	0.125	0.125	0.125	0.125	0.125	0.128	0.131	0.158	0.151	0.161	0.151	0.148	0.151	0.158	0.151	0.194	0.197	0.194	0.194	0.190	0.193	0.193	0.190	0.194	0.194	0.194	0.000	0.000
9-8	0.125	0.125	0.121	0.125	0.128	0.125	0.125	0.125	0.125	0.125	0.125	0.128	0.131	0.158	0.151	0.161	0.151	0.148	0.151	0.158	0.151	0.194	0.197	0.194	0.194	0.190	0.193	0.193	0.190	0.194	0.194	0.194	0.000	0.000
9-9	0.125	0.125	0.121	0.125	0.128	0.125	0.125	0.125	0.125	0.125	0.125	0.128	0.131	0.158	0.151	0.161	0.151	0.148	0.151	0.158	0.151	0.194	0.197	0.194	0.194	0.190	0.193	0.193	0.190	0.194	0.194	0.194	0.000	0.000
10-1	0.214	0.214	0.218	0.218	0.222	0.218	0.218	0.218	0.214	0.207	0.214	0.210	0.214	0.221	0.221	0.213	0.221	0.210	0.225	0.217	0.225	0.244	0.252	0.244	0.244	0.240	0.248	0.248	0.252	0.248	0.244	0.248	0.209	0.209
11-1	0.221	0.221	0.221	0.225	0.229	0.225	0.225	0.225	0.221	0.225	0.221	0.221	0.225	0.260	0.273	0.256	0.269	0.260	0.272	0.252	0.272	0.252	0.260	0.252	0.252	0.256	0.264	0.264	0.252	0.256	0.252	0.256	0.223	0.223
11-2	0.221	0.221	0.221	0.225	0.229	0.225	0.225	0.225	0.221	0.225	0.221	0.221	0.225	0.260	0.273	0.256	0.269	0.260	0.272	0.252	0.272	0.252	0.260	0.252	0.252	0.256	0.264	0.264	0.252	0.256	0.252	0.256	0.223	0.223
11-3	0.221	0.221	0.221	0.225	0.229	0.225	0.225	0.225	0.221	0.225	0.221	0.221	0.225	0.260	0.273	0.256	0.269	0.260	0.272	0.252	0.272	0.252	0.260	0.252	0.252	0.256	0.264	0.264	0.252	0.256	0.252	0.256	0.223	0.223
12-1	0.207	0.207	0.207	0.204	0.207	0.204	0.204	0.204	0.207	0.200	0.207	0.218	0.222	0.272	0.268	0.276	0.268	0.260	0.264	0.272	0.264	0.253	0.253	0.253	0.253	0.253	0.257	0.257	0.253	0.253	0.253	0.253	0.210	0.210
13-1	0.283	0.283	0.288	0.275	0.279	0.275	0.275	0.275	0.283	0.283	0.283	0.271	0.276	0.262	0.279	0.262	0.279	0.262	0.279	0.267	0.279	0.299	0.294	0.299	0.299	0.294	0.298	0.298	0.303	0.299	0.299	0.294	0.240	0.240
13-2	0.283	0.283	0.288	0.275	0.279	0.275	0.275	0.275	0.283	0.283	0.283	0.271	0.276	0.262	0.279	0.262	0.279	0.262	0.279	0.267	0.279	0.299	0.294	0.299	0.299	0.294	0.298	0.298	0.303	0.299	0.299	0.294	0.240	0.240
13-3	0.283	0.283	0.288	0.275	0.279	0.275	0.275	0.275	0.283	0.283	0.283	0.271	0.276	0.262	0.279	0.262	0.279	0.262	0.279	0.267	0.279	0.299	0.294	0.299	0.299	0.294	0.298	0.298	0.303	0.299	0.299	0.294	0.240	0.240
13-4	0.283	0.283	0.288	0.275	0.279	0.275	0.275	0.275	0.283	0.283	0.283	0.271	0.276	0.262	0.279	0.262	0.279	0.262	0.279	0.267	0.279	0.299	0.294	0.299	0.299	0.294	0.298	0.298	0.303	0.299	0.299	0.294	0.240	0.240
13-5	0.279	0.279	0.283	0.271	0.275	0.271	0.271	0.271	0.279	0.279	0.279	0.267	0.271	0.258	0.274	0.258	0.275	0.258	0.275	0.262	0.275	0.294	0.290	0.294	0.294	0.290	0.294	0.294	0.299	0.294	0.294	0.290	0.236	0.236
14-1	0.305	0.305	0.314	0.296	0.300	0.296	0.296	0.296	0.305	0.300	0.305	0.309	0.314	0.315	0.316	0.315	0.320	0.307	0.316	0.320	0.316	0.275	0.275	0.275	0.275	0.275	0.283	0.283	0.279	0.275	0.275	0.271	0.285	0.285
14-2	0.305	0.305	0.314	0.296	0.300	0.296	0.296	0.296	0.305	0.300	0.305	0.309	0.314	0.315	0.316	0.315	0.320	0.307	0.316	0.320	0.316	0.275	0.275	0.275	0.275	0.275	0.283	0.283	0.279	0.275	0.275	0.271	0.285	0.285
14-3	0.305	0.305	0.314	0.296	0.300	0.296	0.296	0.296	0.305	0.300	0.305	0.309	0.314	0.315	0.316	0.315	0.320	0.307	0.316	0.320	0.316	0.275	0.275	0.275	0.275	0.275	0.283	0.283	0.279	0.275	0.275	0.271	0.285	0.285
14-4	0.305	0.305	0.314	0.296	0.300	0.296	0.296	0.296	0.305	0.300	0.305	0.309	0.314	0.315	0.316	0.315	0.320	0.307	0.316	0.320	0.316	0.275	0.275	0.275	0.275	0.275	0.283	0.283	0.279	0.275	0.275	0.271	0.285	0.285
14-5	0.305	0.305	0.314	0.296	0.300	0.296	0.296	0.296	0.305	0.300	0.305	0.309	0.314	0.315	0.316	0.315	0.320	0.307	0.316	0.320	0.316	0.275	0.275	0.275	0.275	0.275	0.283	0.283	0.279	0.275	0.275	0.271	0.285	0.285
14-6	0.305	0.305	0.314	0.296	0.300	0.296	0.296	0.296	0.305	0.300	0.305	0.309	0.314	0.315	0.316	0.315	0.320	0.307	0.316	0.320	0.316	0.275	0.275	0.275	0.275	0.275	0.283	0.283	0.279	0.275	0.275	0.271	0.285	0.285
15-1	0.280	0.280	0.280	0.288	0.293	0.288	0.288	0.288	0.280	0.276	0.280	0.284	0.288	0.310	0.297	0.314	0.305	0.305	0.297	0.319	0.297	0.236	0.232	0.236	0.236	0.232	0.239	0.239	0.232	0.236	0.236	0.236	0.281	0.281
15-2	0.280	0.280	0.280	0.288	0.293	0.288	0.288	0.288	0.280	0.276	0.280	0.284	0.288	0.310	0.297	0.314	0.305	0.305	0.297	0.319	0.297	0.236	0.232	0.236	0.236	0.232	0.239	0.239	0.232	0.236	0.236	0.236	0.281	0.281
16-1	0.260	0.260	0.260	0.244	0.248	0.244	0.244	0.244	0.260	0.252	0.260	0.260	0.260	0.272	0.264	0.268	0.264	0.256	0.260	0.272	0.260	0.228	0.232	0.228	0.228	0.225	0.228	0.228	0.232	0.228	0.228	0.225	0.267	0.267
16-2	0.260	0.260	0.260	0.252	0.256	0.252	0.252	0.252	0.260	0.252	0.260	0.260	0.260	0.264	0.264	0.260	0.264	0.256	0.260	0.264	0.260	0.240	0.244	0.240	0.240	0.236	0.240	0.240	0.244	0.240	0.240	0.236	0.279	0.279
16-3	0.252	0.252	0.252	0.236	0.240	0.236	0.236	0.236	0.252	0.244	0.252	0.252	0.252	0.272	0.272	0.268	0.264	0.264	0.260	0.272	0.260	0.228	0.232	0.228	0.228	0.225	0.228	0.228	0.232	0.228	0.228	0.225	0.267	0.267
17-1	0.233	0.233	0.241	0.229	0.233	0.229	0.229	0.229	0.233	0.237	0.237	0.233	0.237	0.250	0.246	0.254	0.250	0.242	0.246	0.258	0.246	0.242	0.238	0.242	0.242	0.238	0.245	0.245	0.246	0.242	0.242	0.242	0.246	0.246
17-2	0.233	0.233	0.241	0.229	0.233	0.229	0.229	0.229	0.233	0.237	0.237	0.233	0.237	0.250	0.246	0.254	0.250	0.242	0.246	0.258	0.246	0.242	0.238	0.242	0.242	0.238	0.245	0.245	0.246	0.242	0.242	0.242	0.246	0.246
17-3	0.225	0.225	0.233	0.222	0.225	0.222	0.222	0.222	0.225	0.229	0.229	0.225	0.229	0.250	0.246	0.254	0.250	0.242	0.246	0.258	0.246	0.234	0.230	0.234	0.234	0.230	0.237	0.237	0.238	0.234	0.234	0.234	0.234	0.234
18-1	0.250	0.250	0.258	0.254	0.258	0.254	0.254	0.254	0.250	0.254	0.250	0.258	0.262	0.273	0.278	0.265	0.282	0.265	0.278	0.269	0.278	0.234	0.238	0.234	0.234	0.238	0.238	0.238	0.238	0.234	0.234	0.238	0.282	0.282
18-2	0.250	0.250	0.258	0.254	0.258	0.254	0.254	0.254	0.250	0.254	0.250	0.258	0.262	0.273	0.278	0.265	0.282	0.265	0.278	0.269	0.278	0.234	0.238	0.234	0.234	0.238	0.238	0.238	0.238	0.234	0.234	0.238	0.282	0.282
18-3	0.249	0.249	0.257	0.253	0.257	0.253	0.253	0.253	0.249	0.253	0.249	0.257	0.262	0.273	0.277	0.265	0.281	0.265	0.277	0.269	0.277	0.234	0.238	0.234	0.234	0.238	0.237	0.237	0.238	0.234	0.234	0.238	0.281	0.281

Table 1. Continued.

	9-3	9-4	9-5	9-6	9-7	9-8	9-9	10-1	11-1	11-2	11-3	12-1	13-1	13-2	13-3	13-4	13-5	14-1	14-2	14-3	14-4	14-5	14-6	15-1	15-2	16-1	16-2	16-3	17-1	17-2	17-3	18-1	18-2	18-3
9-3																																		
9-4	0.000																																	
9-5	0.000	0.000																																
9-6	0.000	0.000	0.000																															
9-7	0.000	0.000	0.000	0.000																														
9-8	0.000	0.000	0.000	0.000	0.000																													
9-9	0.000	0.000	0.000	0.000	0.000	0.000																												
10-1	0.209	0.209	0.209	0.209	0.209	0.209	0.209																											
11-1	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.159																										
11-2	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.159	0.000																									
11-3	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.159	0.000	0.000																								
12-1	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.208	0.211	0.211	0.211																							
13-1	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.241	0.242	0.242	0.242	0.267																						
13-2	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.241	0.242	0.242	0.242	0.267	0.000																					
13-3	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.241	0.242	0.242	0.242	0.267	0.000	0.000																				
13-4	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.241	0.242	0.242	0.242	0.267	0.000	0.000	0.000																			
13-5	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.245	0.246	0.246	0.246	0.271	0.003	0.003	0.003	0.003																		
14-1	0.285	0.285	0.285	0.285	0.285	0.285	0.285	0.274	0.267	0.267	0.267	0.276	0.241	0.241	0.241	0.241	0.245																	
14-2	0.285	0.285	0.285	0.285	0.285	0.285	0.285	0.274	0.267	0.267	0.267	0.271	0.237	0.237	0.237	0.237	0.241	0.003																
14-3	0.285	0.285	0.285	0.285	0.285	0.285	0.285	0.274	0.271	0.271	0.271	0.271	0.241	0.241	0.241	0.241	0.245	0.005	0.003															
14-4	0.285	0.285	0.285	0.285	0.285	0.285	0.285	0.274	0.267	0.267	0.267	0.271	0.237	0.237	0.237	0.237	0.241	0.003	0.000	0.003														
14-5	0.285	0.285	0.285	0.285	0.285	0.285	0.285	0.274	0.267	0.267	0.267	0.271	0.237	0.237	0.237	0.237	0.241	0.003	0.000	0.003	0.000													
14-6	0.285	0.285	0.285	0.285	0.285	0.285	0.285	0.274	0.267	0.267	0.267	0.271	0.237	0.237	0.237	0.237	0.241	0.003	0.000	0.003	0.000	0.000												
15-1	0.281	0.281	0.281	0.281	0.281	0.281	0.281	0.253	0.265	0.265	0.265	0.255	0.174	0.174	0.174	0.174	0.178	0.249	0.253	0.249	0.253	0.253	0.253											
15-2	0.281	0.281	0.281	0.281	0.281	0.281	0.281	0.253	0.265	0.265	0.265	0.255	0.174	0.174	0.174	0.174	0.178	0.249	0.253	0.249	0.253	0.253	0.253	0.000										
16-1	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.247	0.251	0.251	0.251	0.206	0.171	0.171	0.171	0.171	0.174	0.233	0.229	0.233	0.229	0.229	0.229	0.122	0.122									
16-2	0.279	0.279	0.279	0.279	0.279	0.279	0.279	0.243	0.255	0.255	0.255	0.225	0.163	0.163	0.163	0.163	0.167	0.229	0.225	0.229	0.225	0.225	0.225	0.122	0.122	0.019								
16-3	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.247	0.243	0.243	0.243	0.213	0.171	0.171	0.171	0.171	0.174	0.241	0.237	0.241	0.237	0.237	0.237	0.129	0.129	0.005	0.025							
17-1	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.215	0.230	0.230	0.230	0.232	0.202	0.202	0.202	0.202	0.206	0.221	0.218	0.218	0.218	0.218	0.218	0.181	0.181	0.190	0.190	0.198						
17-2	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.215	0.230	0.230	0.230	0.232	0.202	0.202	0.202	0.202	0.206	0.221	0.218	0.218	0.218	0.218	0.218	0.181	0.181	0.190	0.190	0.198	0.000					
17-3	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.207	0.222	0.222	0.222	0.236	0.191	0.191	0.191	0.191	0.194	0.225	0.221	0.221	0.221	0.221	0.221	0.185	0.185	0.194	0.194	0.194	0.008	0.008				
18-1	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.237	0.238	0.238	0.238	0.227	0.194	0.194	0.194	0.194	0.197	0.244	0.240	0.240	0.240	0.240	0.240	0.231	0.231	0.224	0.224	0.224	0.190	0.190	0.190			
18-2	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.237	0.238	0.238	0.238	0.227	0.194	0.194	0.194	0.194	0.197	0.244	0.240	0.240	0.240	0.240	0.240	0.231	0.231	0.224	0.224	0.224	0.190	0.190	0.190	0.000		
18-3	0.281	0.281	0.281	0.281	0.281	0.281	0.281	0.237	0.237	0.237	0.237	0.227	0.193	0.193	0.193	0.193	0.197	0.244	0.240	0.240	0.240	0.240	0.240	0.231	0.231	0.221	0.221	0.221	0.190	0.190	0.190	0.003	0.003	

Table 1. Continued.

	1-1	1-2	1-3	2-1	3-1	4-1	4-2	4-3	5-1	5-2	6-1	6-2	6-3	6-4	6-5	6-6	6-7	6-8	6-9	6-10	6-11	6-12	6-13	6-14	6-15	6-16	6-17	6-18	6-19	6-20	6-21	6-22	6-23	6-24
18-4	0.243	0.243	0.243	0.217	0.216	0.215	0.211	0.211	0.242	0.238	0.258	0.254	0.254	0.254	0.254	0.254	0.254	0.254	0.258	0.254	0.254	0.254	0.258	0.250	0.270	0.270	0.270	0.270	0.270	0.250	0.254	0.250	0.254	0.250
18-5	0.243	0.243	0.243	0.217	0.216	0.215	0.211	0.211	0.242	0.238	0.258	0.254	0.254	0.254	0.254	0.254	0.254	0.254	0.258	0.254	0.254	0.254	0.258	0.250	0.270	0.270	0.270	0.270	0.270	0.250	0.254	0.250	0.254	0.250
19-1	0.257	0.257	0.257	0.222	0.231	0.216	0.212	0.212	0.249	0.253	0.244	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.232	0.229	0.229	0.229	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.229	0.232	0.229	0.232
19-2	0.261	0.261	0.261	0.219	0.235	0.212	0.209	0.209	0.253	0.257	0.240	0.225	0.225	0.225	0.225	0.225	0.225	0.225	0.229	0.225	0.225	0.225	0.229	0.229	0.228	0.228	0.228	0.228	0.228	0.229	0.225	0.229	0.225	0.229
19-3	0.261	0.261	0.261	0.219	0.235	0.212	0.209	0.209	0.253	0.257	0.240	0.225	0.225	0.225	0.225	0.225	0.225	0.225	0.229	0.225	0.225	0.225	0.229	0.229	0.228	0.228	0.228	0.228	0.228	0.229	0.225	0.229	0.225	0.229
19-4	0.261	0.261	0.261	0.219	0.235	0.212	0.209	0.209	0.253	0.257	0.240	0.225	0.225	0.225	0.225	0.225	0.225	0.225	0.229	0.225	0.225	0.225	0.229	0.229	0.228	0.228	0.228	0.228	0.228	0.229	0.225	0.229	0.225	0.229
19-5	0.261	0.261	0.261	0.219	0.235	0.212	0.209	0.209	0.253	0.257	0.240	0.225	0.225	0.225	0.225	0.225	0.225	0.225	0.229	0.225	0.225	0.225	0.229	0.229	0.228	0.228	0.228	0.228	0.228	0.229	0.225	0.229	0.225	0.229
19-6	0.261	0.261	0.261	0.219	0.235	0.212	0.209	0.209	0.253	0.257	0.240	0.225	0.225	0.225	0.225	0.225	0.225	0.225	0.229	0.225	0.225	0.225	0.229	0.229	0.228	0.228	0.228	0.228	0.228	0.229	0.225	0.229	0.225	0.229
19-7	0.261	0.261	0.261	0.219	0.235	0.212	0.209	0.209	0.253	0.257	0.240	0.225	0.225	0.225	0.225	0.225	0.225	0.225	0.229	0.225	0.225	0.225	0.229	0.229	0.228	0.228	0.228	0.228	0.228	0.229	0.225	0.229	0.225	0.229
20-1	0.240	0.240	0.240	0.232	0.201	0.190	0.190	0.190	0.240	0.228	0.235	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.228	0.235	0.235	0.232	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.239	0.235	0.239	0.232	0.239
20-2	0.240	0.240	0.240	0.232	0.201	0.190	0.190	0.190	0.240	0.228	0.235	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.228	0.235	0.235	0.232	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.239	0.235	0.239	0.232	0.239
20-3	0.240	0.240	0.240	0.232	0.201	0.190	0.190	0.190	0.240	0.228	0.235	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.228	0.235	0.235	0.232	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.239	0.235	0.239	0.232	0.239
20-4	0.240	0.240	0.240	0.232	0.201	0.190	0.190	0.190	0.240	0.228	0.235	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.228	0.235	0.235	0.232	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.239	0.235	0.239	0.232	0.239
20-5	0.240	0.240	0.240	0.232	0.201	0.190	0.190	0.190	0.240	0.228	0.235	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.228	0.235	0.235	0.232	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.239	0.235	0.239	0.232	0.239
20-6	0.240	0.240	0.240	0.232	0.201	0.190	0.190	0.190	0.240	0.228	0.235	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.228	0.235	0.235	0.232	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.239	0.235	0.239	0.232	0.239
20-7	0.240	0.240	0.240	0.232	0.201	0.190	0.190	0.190	0.240	0.228	0.235	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.228	0.235	0.235	0.232	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.239	0.235	0.239	0.232	0.239
20-8	0.240	0.240	0.240	0.232	0.198	0.186	0.186	0.186	0.240	0.228	0.235	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.228	0.235	0.235	0.232	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.239	0.235	0.239	0.232	0.239
21-1	0.232	0.232	0.232	0.267	0.212	0.197	0.204	0.204	0.260	0.248	0.285	0.277	0.281	0.277	0.277	0.281	0.277	0.277	0.285	0.285	0.285	0.281	0.277	0.285	0.268	0.268	0.268	0.268	0.268	0.289	0.285	0.289	0.281	0.289
21-2	0.232	0.232	0.232	0.267	0.212	0.197	0.204	0.204	0.260	0.248	0.285	0.277	0.281	0.277	0.277	0.281	0.277	0.277	0.285	0.285	0.285	0.281	0.277	0.285	0.268	0.268	0.268	0.268	0.268	0.289	0.285	0.289	0.281	0.289
22-1	0.239	0.239	0.239	0.223	0.186	0.211	0.211	0.211	0.213	0.232	0.252	0.248	0.256	0.248	0.248	0.256	0.248	0.248	0.260	0.260	0.260	0.256	0.252	0.252	0.255	0.255	0.255	0.255	0.255	0.256	0.260	0.256	0.256	0.256
23-1	0.260	0.260	0.260	0.255	0.181	0.190	0.190	0.190	0.232	0.247	0.244	0.252	0.248	0.252	0.252	0.248	0.252	0.252	0.252	0.252	0.252	0.248	0.252	0.244	0.244	0.244	0.244	0.244	0.244	0.248	0.252	0.248	0.248	0.248
23-2	0.260	0.260	0.260	0.255	0.181	0.190	0.190	0.190	0.232	0.247	0.244	0.252	0.248	0.252	0.252	0.248	0.252	0.252	0.252	0.252	0.252	0.248	0.252	0.244	0.244	0.244	0.244	0.244	0.244	0.248	0.252	0.248	0.248	0.248
24-1	0.235	0.235	0.235	0.276	0.271	0.271	0.267	0.267	0.254	0.246	0.237	0.245	0.225	0.245	0.245	0.225	0.245	0.245	0.229	0.225	0.225	0.225	0.229	0.229	0.237	0.237	0.237	0.237	0.237	0.229	0.225	0.229	0.225	0.229
24-2	0.231	0.231	0.231	0.280	0.271	0.271	0.267	0.267	0.254	0.246	0.241	0.249	0.229	0.249	0.249	0.229	0.249	0.249	0.233	0.229	0.229	0.229	0.233	0.233	0.241	0.241	0.241	0.241	0.241	0.233	0.229	0.233	0.229	0.233
24-3	0.235	0.235	0.235	0.276	0.271	0.271	0.267	0.267	0.254	0.246	0.237	0.245	0.225	0.245	0.245	0.225	0.245	0.245	0.229	0.225	0.225	0.225	0.229	0.229	0.237	0.237	0.237	0.237	0.237	0.229	0.225	0.229	0.225	0.229
25-1	0.259	0.259	0.259	0.273	0.244	0.236	0.224	0.224	0.236	0.228	0.195	0.199	0.206	0.199	0.199	0.206	0.199	0.199	0.210	0.206	0.206	0.206	0.210	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.206	0.202	0.206	0.202
25-2	0.259	0.259	0.259	0.273	0.244	0.236	0.224	0.224	0.236	0.228	0.195	0.199	0.206	0.199	0.199	0.206	0.199	0.199	0.210	0.206	0.206	0.206	0.210	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.206	0.202	0.206	0.202
25-3	0.259	0.259	0.259	0.273	0.244	0.236	0.224	0.224	0.236	0.228	0.195	0.199	0.206	0.199	0.199	0.206	0.199	0.199	0.210	0.206	0.206	0.206	0.210	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.206	0.202	0.206	0.202
26-1	0.269	0.269	0.269	0.229	0.252	0.267	0.267	0.267	0.287	0.278	0.264	0.264	0.277	0.264	0.264	0.277	0.264	0.264	0.281	0.281	0.281	0.277	0.281	0.272	0.256	0.256	0.256	0.256	0.256	0.277	0.281	0.277	0.277	0.277
26-2	0.269	0.269	0.269	0.229	0.252	0.267	0.267	0.267	0.287	0.278	0.264	0.264	0.277	0.264	0.264	0.277	0.264	0.264	0.281	0.281	0.281	0.277	0.281	0.272	0.256	0.256	0.256	0.256	0.256	0.277	0.281	0.277	0.277	0.277
26-3	0.269	0.269	0.269	0.229	0.252	0.267	0.267	0.267	0.287	0.278	0.264	0.264	0.277	0.264	0.264	0.277	0.264	0.264	0.281	0.281	0.281	0.277	0.281	0.272	0.256	0.256	0.256	0.256	0.256	0.277	0.281	0.277	0.277	0.277
25-4	0.259	0.259	0.259	0.273	0.244	0.236	0.224	0.224	0.236	0.228	0.195	0.199	0.206	0.199	0.199	0.206	0.199	0.199	0.210	0.206	0.206	0.206	0.210	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.206	0.202	0.206	0.202
25-5	0.259	0.259	0.259	0.273	0.244	0.236	0.224	0.224	0.236	0.228	0.195	0.199	0.206	0.199	0.199	0.206	0.199	0.199	0.210	0.206	0.206	0.206	0.210	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.206	0.202	0.206	0.202
25-6	0.259	0.259	0.259	0.273	0.244	0.236	0.224	0.224	0.236	0.228	0.195	0.199	0.206	0.199	0.199	0.206	0.199	0.199	0.210	0.206	0.206	0.206	0.210	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.206	0.202	0.206	0.202

Table 1. Continued.

	6-25	6-26	6-27	6-28	6-29	6-30	6-31	6-32	6-33	6-34	6-35	6-36	6-37	7-1	7-2	7-3	7-4	7-5	7-6	7-7	7-8	8-1	8-2	8-3	8-4	8-5	8-6	8-7	8-8	8-9	8-10	8-11	9-1	9-2
18-4	0.250	0.250	0.258	0.254	0.258	0.254	0.254	0.254	0.250	0.254	0.250	0.258	0.262	0.273	0.278	0.265	0.282	0.265	0.278	0.269	0.278	0.234	0.238	0.234	0.234	0.238	0.238	0.238	0.238	0.234	0.234	0.238	0.282	0.282
18-5	0.250	0.250	0.258	0.254	0.258	0.254	0.254	0.254	0.250	0.254	0.250	0.258	0.262	0.273	0.278	0.265	0.282	0.265	0.278	0.269	0.278	0.234	0.238	0.234	0.234	0.238	0.238	0.238	0.238	0.234	0.234	0.238	0.282	0.282
19-1	0.232	0.232	0.232	0.229	0.232	0.229	0.229	0.229	0.232	0.229	0.232	0.244	0.248	0.263	0.267	0.267	0.271	0.263	0.267	0.263	0.267	0.273	0.269	0.273	0.273	0.269	0.277	0.277	0.269	0.273	0.273	0.277	0.221	0.221
19-2	0.229	0.229	0.229	0.225	0.229	0.225	0.225	0.225	0.229	0.225	0.229	0.240	0.244	0.267	0.271	0.271	0.275	0.267	0.271	0.267	0.271	0.269	0.265	0.269	0.269	0.265	0.273	0.273	0.265	0.269	0.269	0.273	0.217	0.217
19-3	0.229	0.229	0.229	0.225	0.229	0.225	0.225	0.225	0.229	0.225	0.229	0.240	0.244	0.267	0.271	0.271	0.275	0.267	0.271	0.267	0.271	0.269	0.265	0.269	0.269	0.265	0.273	0.273	0.265	0.269	0.269	0.273	0.217	0.217
19-4	0.229	0.229	0.229	0.225	0.229	0.225	0.225	0.225	0.229	0.225	0.229	0.240	0.244	0.267	0.271	0.271	0.275	0.267	0.271	0.267	0.271	0.269	0.265	0.269	0.269	0.265	0.273	0.273	0.265	0.269	0.269	0.273	0.217	0.217
19-5	0.229	0.229	0.229	0.225	0.229	0.225	0.225	0.225	0.229	0.225	0.229	0.240	0.244	0.267	0.271	0.271	0.275	0.267	0.271	0.267	0.271	0.269	0.265	0.269	0.269	0.265	0.273	0.273	0.265	0.269	0.269	0.273	0.217	0.217
19-6	0.229	0.229	0.229	0.225	0.229	0.225	0.225	0.225	0.229	0.225	0.229	0.240	0.244	0.267	0.271	0.271	0.275	0.267	0.271	0.267	0.271	0.269	0.265	0.269	0.269	0.265	0.273	0.273	0.265	0.269	0.269	0.273	0.217	0.217
19-7	0.229	0.229	0.229	0.225	0.229	0.225	0.225	0.225	0.229	0.225	0.229	0.240	0.244	0.267	0.271	0.271	0.275	0.267	0.271	0.267	0.271	0.269	0.265	0.269	0.269	0.265	0.273	0.273	0.265	0.269	0.269	0.273	0.217	0.217
20-1	0.239	0.239	0.235	0.232	0.235	0.232	0.232	0.232	0.239	0.239	0.243	0.239	0.243	0.266	0.278	0.274	0.279	0.262	0.275	0.270	0.275	0.248	0.248	0.248	0.248	0.244	0.255	0.255	0.244	0.248	0.248	0.248	0.229	0.229
20-2	0.239	0.239	0.235	0.232	0.235	0.232	0.232	0.232	0.239	0.239	0.243	0.239	0.243	0.266	0.278	0.274	0.279	0.262	0.275	0.270	0.275	0.248	0.248	0.248	0.248	0.244	0.255	0.255	0.244	0.248	0.248	0.248	0.229	0.229
20-3	0.239	0.239	0.235	0.232	0.235	0.232	0.232	0.232	0.239	0.239	0.243	0.239	0.243	0.266	0.278	0.274	0.279	0.262	0.275	0.270	0.275	0.248	0.248	0.248	0.248	0.244	0.255	0.255	0.244	0.248	0.248	0.248	0.229	0.229
20-4	0.239	0.239	0.235	0.232	0.235	0.232	0.232	0.232	0.239	0.239	0.243	0.239	0.243	0.266	0.278	0.274	0.279	0.262	0.275	0.270	0.275	0.248	0.248	0.248	0.248	0.244	0.255	0.255	0.244	0.248	0.248	0.248	0.229	0.229
20-5	0.239	0.239	0.235	0.232	0.235	0.232	0.232	0.232	0.239	0.239	0.243	0.239	0.243	0.266	0.278	0.274	0.279	0.262	0.275	0.270	0.275	0.248	0.248	0.248	0.248	0.244	0.255	0.255	0.244	0.248	0.248	0.248	0.229	0.229
20-6	0.239	0.239	0.235	0.232	0.235	0.232	0.232	0.232	0.239	0.239	0.243	0.239	0.243	0.266	0.278	0.274	0.279	0.262	0.275	0.270	0.275	0.248	0.248	0.248	0.248	0.244	0.255	0.255	0.244	0.248	0.248	0.248	0.229	0.229
20-7	0.239	0.239	0.235	0.232	0.235	0.232	0.232	0.232	0.239	0.239	0.243	0.239	0.243	0.266	0.278	0.274	0.279	0.262	0.275	0.270	0.275	0.248	0.248	0.248	0.248	0.244	0.255	0.255	0.244	0.248	0.248	0.248	0.229	0.229
20-8	0.239	0.239	0.235	0.232	0.235	0.232	0.232	0.232	0.239	0.239	0.243	0.239	0.243	0.266	0.278	0.274	0.279	0.262	0.275	0.270	0.275	0.248	0.248	0.248	0.248	0.244	0.255	0.255	0.244	0.248	0.248	0.248	0.229	0.229
21-1	0.289	0.289	0.285	0.277	0.281	0.277	0.277	0.277	0.289	0.289	0.289	0.289	0.294	0.271	0.267	0.267	0.267	0.263	0.264	0.271	0.264	0.280	0.285	0.280	0.280	0.280	0.285	0.285	0.276	0.280	0.280	0.276	0.249	0.249
21-2	0.289	0.289	0.285	0.277	0.281	0.277	0.277	0.277	0.289	0.289	0.289	0.289	0.294	0.271	0.267	0.267	0.267	0.263	0.264	0.271	0.264	0.280	0.285	0.280	0.280	0.280	0.285	0.285	0.276	0.280	0.280	0.276	0.249	0.249
22-1	0.256	0.256	0.260	0.248	0.252	0.248	0.248	0.248	0.256	0.256	0.260	0.256	0.260	0.256	0.256	0.256	0.256	0.240	0.256	0.252	0.256	0.284	0.293	0.284	0.284	0.284	0.284	0.284	0.289	0.284	0.284	0.284	0.229	0.229
23-1	0.248	0.248	0.252	0.252	0.256	0.252	0.252	0.252	0.248	0.248	0.244	0.248	0.252	0.272	0.280	0.285	0.280	0.264	0.277	0.280	0.277	0.232	0.228	0.232	0.232	0.228	0.232	0.232	0.236	0.232	0.232	0.232	0.232	0.232
23-2	0.248	0.248	0.252	0.252	0.256	0.252	0.252	0.252	0.248	0.248	0.244	0.248	0.252	0.272	0.280	0.285	0.280	0.264	0.277	0.280	0.277	0.232	0.228	0.232	0.232	0.228	0.232	0.232	0.236	0.232	0.232	0.232	0.232	0.232
24-1	0.229	0.229	0.225	0.245	0.249	0.245	0.245	0.245	0.229	0.229	0.229	0.237	0.237	0.275	0.279	0.271	0.283	0.267	0.291	0.275	0.291	0.280	0.285	0.280	0.280	0.276	0.293	0.293	0.280	0.285	0.280	0.280	0.264	0.264
24-2	0.233	0.233	0.229	0.249	0.253	0.249	0.249	0.249	0.233	0.233	0.233	0.241	0.241	0.275	0.279	0.271	0.283	0.267	0.291	0.275	0.291	0.280	0.285	0.280	0.280	0.276	0.293	0.293	0.280	0.285	0.280	0.280	0.264	0.264
24-3	0.229	0.229	0.225	0.245	0.249	0.245	0.245	0.245	0.229	0.229	0.229	0.237	0.237	0.275	0.279	0.271	0.283	0.267	0.291	0.275	0.291	0.280	0.285	0.280	0.280	0.276	0.293	0.293	0.280	0.285	0.280	0.280	0.264	0.264
25-1	0.202	0.202	0.210	0.199	0.202	0.199	0.199	0.199	0.202	0.202	0.202	0.195	0.199	0.270	0.270	0.274	0.266	0.270	0.266	0.270	0.266	0.239	0.247	0.239	0.239	0.235	0.243	0.243	0.243	0.239	0.239	0.235	0.206	0.206
25-2	0.202	0.202	0.210	0.199	0.202	0.199	0.199	0.199	0.202	0.202	0.202	0.195	0.199	0.270	0.270	0.274	0.266	0.270	0.266	0.270	0.266	0.239	0.247	0.239	0.239	0.235	0.243	0.243	0.243	0.239	0.239	0.235	0.206	0.206
25-3	0.202	0.202	0.210	0.199	0.202	0.199	0.199	0.199	0.202	0.202	0.202	0.195	0.199	0.270	0.270	0.274	0.266	0.270	0.266	0.270	0.266	0.239	0.247	0.239	0.239	0.235	0.243	0.243	0.243	0.239	0.239	0.235	0.206	0.206
26-1	0.277	0.277	0.272	0.264	0.268	0.264	0.264	0.264	0.277	0.268	0.277	0.268	0.264	0.236	0.240	0.228	0.240	0.228	0.240	0.232	0.240	0.242	0.246	0.242	0.242	0.238	0.249	0.249	0.246	0.242	0.242	0.246	0.254	0.254
26-2	0.277	0.277	0.272	0.264	0.268	0.264	0.264	0.264	0.277	0.268	0.277	0.268	0.264	0.236	0.240	0.228	0.240	0.228	0.240	0.232	0.240	0.242	0.246	0.242	0.242	0.238	0.249	0.249	0.246	0.242	0.242	0.246	0.254	0.254
26-3	0.277	0.277	0.272	0.264	0.268	0.264	0.264	0.264	0.277	0.268	0.277	0.268	0.264	0.236	0.240	0.228	0.240	0.228	0.240	0.232	0.240	0.242	0.246	0.242	0.242	0.238	0.249	0.249	0.246	0.242	0.242	0.246	0.254	0.254
25-4	0.202	0.202	0.210	0.199	0.202	0.199	0.199	0.199	0.202	0.202	0.202	0.195	0.199	0.270	0.270	0.274	0.266	0.270	0.266	0.270	0.266	0.239	0.247	0.239	0.239	0.235	0.243	0.243	0.243	0.239	0.239	0.235	0.206	0.206
25-5	0.202	0.202	0.210	0.199	0.202	0.199	0.199	0.199	0.202	0.202	0.202	0.195	0.199	0.270	0.270	0.274	0.266	0.270	0.266	0.270	0.266	0.239	0.247	0.239	0.239	0.235	0.243	0.243	0.243	0.239	0.239	0.235	0.206	0.206
25-6	0.202	0.202	0.210	0.199	0.202	0.199	0.199	0.199	0.202	0.202	0.202	0.195	0.199	0.270	0.270	0.274	0.266	0.270	0.266	0.270	0.266	0.239	0.247	0.239	0.239	0.235	0.243	0.243	0.243	0.239	0.239	0.235	0.206	0.206

Table 1. Continued.

	9-3	9-4	9-5	9-6	9-7	9-8	9-9	10-1	11-1	11-2	11-3	12-1	13-1	13-2	13-3	13-4	13-5	14-1	14-2	14-3	14-4	14-5	14-6	15-1	15-2	16-1	16-2	16-3	17-1	17-2	17-3	18-1	18-2	18-3
18-4	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.237	0.238	0.238	0.238	0.227	0.194	0.194	0.194	0.194	0.197	0.244	0.240	0.240	0.240	0.240	0.240	0.231	0.231	0.224	0.224	0.224	0.190	0.190	0.190	0.000	0.000	0.003
18-5	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.237	0.238	0.238	0.238	0.227	0.194	0.194	0.194	0.194	0.197	0.244	0.240	0.240	0.240	0.240	0.240	0.231	0.231	0.224	0.224	0.224	0.190	0.190	0.190	0.000	0.000	0.003
19-1	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.224	0.240	0.240	0.240	0.214	0.200	0.200	0.200	0.200	0.204	0.259	0.255	0.255	0.255	0.255	0.255	0.228	0.228	0.225	0.217	0.225	0.201	0.201	0.194	0.154	0.154	0.154
19-2	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.228	0.236	0.236	0.236	0.210	0.204	0.204	0.204	0.204	0.208	0.255	0.251	0.251	0.251	0.251	0.251	0.224	0.224	0.221	0.213	0.221	0.198	0.198	0.190	0.158	0.158	0.157
19-3	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.228	0.236	0.236	0.236	0.210	0.204	0.204	0.204	0.204	0.208	0.255	0.251	0.251	0.251	0.251	0.251	0.224	0.224	0.221	0.213	0.221	0.198	0.198	0.190	0.158	0.158	0.157
19-4	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.228	0.236	0.236	0.236	0.210	0.204	0.204	0.204	0.204	0.208	0.255	0.251	0.251	0.251	0.251	0.251	0.224	0.224	0.221	0.213	0.221	0.198	0.198	0.190	0.158	0.158	0.157
19-5	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.228	0.236	0.236	0.236	0.210	0.204	0.204	0.204	0.204	0.208	0.255	0.251	0.251	0.251	0.251	0.251	0.224	0.224	0.221	0.213	0.221	0.198	0.198	0.190	0.158	0.158	0.157
19-6	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.228	0.236	0.236	0.236	0.210	0.204	0.204	0.204	0.204	0.208	0.255	0.251	0.251	0.251	0.251	0.251	0.224	0.224	0.221	0.213	0.221	0.198	0.198	0.190	0.158	0.158	0.157
19-7	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.228	0.236	0.236	0.236	0.210	0.204	0.204	0.204	0.204	0.208	0.255	0.251	0.251	0.251	0.251	0.251	0.224	0.224	0.221	0.213	0.221	0.198	0.198	0.190	0.158	0.158	0.157
20-1	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.245	0.217	0.217	0.217	0.199	0.209	0.209	0.209	0.209	0.213	0.215	0.211	0.211	0.211	0.211	0.211	0.178	0.178	0.198	0.191	0.206	0.180	0.180	0.184	0.238	0.238	0.238
20-2	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.245	0.217	0.217	0.217	0.199	0.209	0.209	0.209	0.209	0.213	0.215	0.211	0.211	0.211	0.211	0.211	0.178	0.178	0.198	0.191	0.206	0.180	0.180	0.184	0.238	0.238	0.238
20-3	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.245	0.217	0.217	0.217	0.199	0.209	0.209	0.209	0.209	0.213	0.215	0.211	0.211	0.211	0.211	0.211	0.178	0.178	0.198	0.191	0.206	0.180	0.180	0.184	0.238	0.238	0.238
20-4	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.245	0.217	0.217	0.217	0.199	0.209	0.209	0.209	0.209	0.213	0.215	0.211	0.211	0.211	0.211	0.211	0.178	0.178	0.198	0.191	0.206	0.180	0.180	0.184	0.238	0.238	0.238
20-5	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.245	0.217	0.217	0.217	0.199	0.209	0.209	0.209	0.209	0.213	0.215	0.211	0.211	0.211	0.211	0.211	0.178	0.178	0.198	0.191	0.206	0.180	0.180	0.184	0.238	0.238	0.238
20-6	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.245	0.217	0.217	0.217	0.199	0.209	0.209	0.209	0.209	0.213	0.215	0.211	0.211	0.211	0.211	0.211	0.178	0.178	0.198	0.191	0.206	0.180	0.180	0.184	0.238	0.238	0.238
20-7	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.245	0.217	0.217	0.217	0.199	0.209	0.209	0.209	0.209	0.213	0.215	0.211	0.211	0.211	0.211	0.211	0.178	0.178	0.198	0.191	0.206	0.180	0.180	0.184	0.238	0.238	0.238
20-8	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.245	0.217	0.217	0.217	0.199	0.205	0.205	0.205	0.205	0.209	0.211	0.207	0.207	0.207	0.207	0.207	0.174	0.174	0.194	0.187	0.202	0.176	0.176	0.180	0.238	0.238	0.238
21-1	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.272	0.252	0.252	0.252	0.260	0.195	0.195	0.195	0.195	0.199	0.230	0.226	0.226	0.226	0.226	0.226	0.236	0.236	0.201	0.197	0.201	0.209	0.209	0.198	0.230	0.230	0.230
21-2	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.272	0.252	0.252	0.252	0.260	0.195	0.195	0.195	0.195	0.199	0.230	0.226	0.226	0.226	0.226	0.226	0.236	0.236	0.201	0.197	0.201	0.209	0.209	0.198	0.230	0.230	0.230
22-1	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.222	0.234	0.234	0.234	0.245	0.179	0.179	0.179	0.179	0.183	0.255	0.251	0.251	0.251	0.251	0.251	0.222	0.222	0.193	0.197	0.193	0.184	0.184	0.180	0.215	0.215	0.215
23-1	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.237	0.245	0.245	0.245	0.236	0.179	0.179	0.179	0.179	0.183	0.267	0.263	0.263	0.263	0.263	0.263	0.181	0.181	0.184	0.199	0.184	0.199	0.199	0.188	0.231	0.231	0.231
23-2	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.237	0.245	0.245	0.245	0.236	0.179	0.179	0.179	0.179	0.183	0.267	0.263	0.263	0.263	0.263	0.263	0.181	0.181	0.184	0.199	0.184	0.199	0.199	0.188	0.231	0.231	0.231
24-1	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.241	0.230	0.230	0.230	0.268	0.264	0.264	0.264	0.264	0.260	0.299	0.294	0.294	0.294	0.294	0.294	0.319	0.319	0.260	0.252	0.260	0.302	0.302	0.297	0.240	0.240	0.240
24-2	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.245	0.226	0.226	0.226	0.272	0.264	0.264	0.264	0.264	0.260	0.303	0.299	0.299	0.299	0.299	0.299	0.319	0.319	0.260	0.252	0.260	0.302	0.302	0.297	0.236	0.236	0.236
24-3	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.241	0.230	0.230	0.230	0.268	0.264	0.264	0.264	0.264	0.260	0.299	0.294	0.294	0.294	0.294	0.294	0.319	0.319	0.260	0.252	0.260	0.302	0.302	0.297	0.240	0.240	0.240
25-1	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.252	0.225	0.225	0.225	0.243	0.262	0.262	0.262	0.262	0.258	0.296	0.300	0.300	0.300	0.300	0.300	0.296	0.296	0.258	0.267	0.251	0.270	0.270	0.262	0.271	0.271	0.267
25-2	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.252	0.225	0.225	0.225	0.243	0.262	0.262	0.262	0.262	0.258	0.296	0.300	0.300	0.300	0.300	0.300	0.296	0.296	0.258	0.267	0.251	0.270	0.270	0.262	0.271	0.271	0.267
25-3	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.252	0.225	0.225	0.225	0.243	0.262	0.262	0.262	0.262	0.258	0.296	0.300	0.300	0.300	0.300	0.300	0.296	0.296	0.258	0.267	0.251	0.270	0.270	0.262	0.271	0.271	0.267
26-1	0.254	0.254	0.254	0.254	0.254	0.254	0.254	0.251	0.272	0.272	0.272	0.233	0.268	0.268	0.268	0.268	0.264	0.276	0.272	0.272	0.272	0.272	0.272	0.288	0.288	0.250	0.258	0.258	0.255	0.255	0.255	0.276	0.276	0.277
26-2	0.254	0.254	0.254	0.254	0.254	0.254	0.254	0.251	0.272	0.272	0.272	0.233	0.268	0.268	0.268	0.268	0.264	0.276	0.272	0.272	0.272	0.272	0.272	0.288	0.288	0.250	0.258	0.258	0.255	0.255	0.255	0.276	0.276	0.277
26-3	0.254	0.254	0.254	0.254	0.254	0.254	0.254	0.251	0.272	0.272	0.272	0.233	0.268	0.268	0.268	0.268	0.264	0.276	0.272	0.272	0.272	0.272	0.272	0.288	0.288	0.250	0.258	0.258	0.255	0.255	0.255	0.276	0.276	0.277
25-4	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.252	0.225	0.225	0.225	0.243	0.262	0.262	0.262	0.262	0.258	0.296	0.300	0.300	0.300	0.300	0.300	0.296	0.296	0.258	0.267	0.251	0.270	0.270	0.262	0.271	0.271	0.267
25-5	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.252	0.225	0.225	0.225	0.243	0.262	0.262	0.262	0.262	0.258	0.296	0.300	0.300	0.300	0.300	0.300	0.296	0.296	0.258	0.267	0.251	0.270	0.270	0.262	0.271	0.271	0.267
25-6	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.252	0.225	0.225	0.225	0.243	0.262	0.262	0.262	0.262	0.258	0.296	0.300	0.300	0.300	0.300	0.300	0.296	0.296	0.258	0.267	0.251	0.270	0.270	0.262	0.271	0.271	0.267

Table 1. Continued.

	18-4	18-5	19-1	19-2	19-3	19-4	19-5	19-6	19-7	20-1	20-2	20-3	20-4	20-5	20-6	20-7	20-8	21-1	21-2	22-1	23-1	23-2	24-1	24-2	24-3	25-1	25-2	25-3	26-1	26-2	26-3	25-4	25-5	25-6
18-4																																		
18-5	0.000																																	
19-1	0.154	0.154																																
19-2	0.158	0.158	0.003																															
19-3	0.158	0.158	0.003	0.000																														
19-4	0.158	0.158	0.003	0.000	0.000																													
19-5	0.158	0.158	0.003	0.000	0.000	0.000																												
19-6	0.158	0.158	0.003	0.000	0.000	0.000	0.000																											
19-7	0.158	0.158	0.003	0.000	0.000	0.000	0.000	0.000																										
20-1	0.238	0.238	0.208	0.204	0.204	0.204	0.204	0.204	0.204																									
20-2	0.238	0.238	0.208	0.204	0.204	0.204	0.204	0.204	0.204	0.000																								
20-3	0.238	0.238	0.208	0.204	0.204	0.204	0.204	0.204	0.204	0.000	0.000																							
20-4	0.238	0.238	0.208	0.204	0.204	0.204	0.204	0.204	0.204	0.000	0.000	0.000																						
20-5	0.238	0.238	0.208	0.204	0.204	0.204	0.204	0.204	0.204	0.000	0.000	0.000	0.000																					
20-6	0.238	0.238	0.208	0.204	0.204	0.204	0.204	0.204	0.204	0.000	0.000	0.000	0.000	0.000																				
20-7	0.238	0.238	0.208	0.204	0.204	0.204	0.204	0.204	0.204	0.000	0.000	0.000	0.000	0.000	0.000																			
20-8	0.238	0.238	0.204	0.201	0.201	0.201	0.201	0.201	0.201	0.003	0.003	0.003	0.003	0.003	0.003	0.003																		
21-1	0.230	0.230	0.234	0.238	0.238	0.238	0.238	0.238	0.238	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.242																	
21-2	0.230	0.230	0.234	0.238	0.238	0.238	0.238	0.238	0.238	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.242	0.000																
22-1	0.215	0.215	0.204	0.200	0.200	0.200	0.200	0.200	0.200	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.204	0.205	0.205															
23-1	0.231	0.231	0.225	0.229	0.229	0.229	0.229	0.229	0.229	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.130	0.232	0.232	0.210														
23-2	0.231	0.231	0.225	0.229	0.229	0.229	0.229	0.229	0.229	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.130	0.232	0.232	0.210	0.000													
24-1	0.240	0.240	0.260	0.264	0.264	0.264	0.264	0.264	0.264	0.255	0.255	0.255	0.255	0.255	0.255	0.255	0.251	0.288	0.288	0.288	0.259	0.259												
24-2	0.236	0.236	0.260	0.264	0.264	0.264	0.264	0.264	0.264	0.255	0.255	0.255	0.255	0.255	0.255	0.255	0.251	0.292	0.292	0.288	0.259	0.259	0.003											
24-3	0.240	0.240	0.260	0.264	0.264	0.264	0.264	0.264	0.264	0.255	0.255	0.255	0.255	0.255	0.255	0.255	0.251	0.288	0.288	0.288	0.259	0.259	0.000	0.003										
25-1	0.271	0.271	0.272	0.276	0.276	0.276	0.276	0.276	0.276	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.271	0.271	0.267	0.248	0.248	0.239	0.239	0.239									
25-2	0.271	0.271	0.272	0.276	0.276	0.276	0.276	0.276	0.276	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.271	0.271	0.267	0.248	0.248	0.239	0.239	0.239	0.000								
25-3	0.271	0.271	0.272	0.276	0.276	0.276	0.276	0.276	0.276	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.271	0.271	0.267	0.248	0.248	0.239	0.239	0.239	0.000	0.000							
26-1	0.276	0.276	0.267	0.263	0.263	0.263	0.263	0.263	0.263	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.281	0.281	0.300	0.288	0.288	0.229	0.229	0.229	0.226	0.226	0.226						
26-2	0.276	0.276	0.267	0.263	0.263	0.263	0.263	0.263	0.263	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.281	0.281	0.300	0.288	0.288	0.229	0.229	0.229	0.226	0.226	0.226	0.000					
26-3	0.276	0.276	0.267	0.263	0.263	0.263	0.263	0.263	0.263	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.281	0.281	0.300	0.288	0.288	0.229	0.229	0.229	0.226	0.226	0.226	0.000	0.000				
25-4	0.271	0.271	0.272	0.276	0.276	0.276	0.276	0.276	0.276	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.271	0.271	0.267	0.248	0.248	0.239	0.239	0.239	0.000	0.000	0.000	0.226	0.226	0.226			
25-5	0.271	0.271	0.272	0.276	0.276	0.276	0.276	0.276	0.276	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.271	0.271	0.267	0.248	0.248	0.239	0.239	0.239	0.000	0.000	0.000	0.226	0.226	0.226	0.000		
25-6	0.271	0.271	0.272	0.276	0.276	0.276	0.276	0.276	0.276	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.271	0.271	0.267	0.248	0.248	0.239	0.239	0.239	0.000	0.000	0.000	0.226	0.226	0.226	0.000	0.000	

Table 1. Continued.

	1-1	1-2	1-3	2-1	3-1	4-1	4-2	4-3	5-1	5-2	6-1	6-2	6-3	6-4	6-5	6-6	6-7	6-8	6-9	6-10	6-11	6-12	6-13	6-14	6-15	6-16	6-17	6-18	6-19	6-20	6-21	6-22	6-23	6-24
27-1	0.237	0.237	0.237	0.263	0.258	0.270	0.262	0.262	0.274	0.266	0.267	0.258	0.266	0.258	0.258	0.266	0.258	0.258	0.270	0.270	0.270	0.266	0.262	0.270	0.243	0.243	0.243	0.243	0.243	0.274	0.270	0.274	0.266	0.274
27-2	0.237	0.237	0.237	0.267	0.251	0.262	0.254	0.254	0.270	0.262	0.263	0.254	0.262	0.254	0.254	0.262	0.254	0.254	0.266	0.266	0.266	0.262	0.266	0.266	0.235	0.235	0.235	0.235	0.235	0.270	0.266	0.270	0.262	0.270
27-3	0.241	0.241	0.241	0.267	0.258	0.274	0.266	0.266	0.274	0.266	0.263	0.262	0.270	0.262	0.262	0.270	0.262	0.262	0.274	0.274	0.274	0.270	0.266	0.274	0.247	0.247	0.247	0.247	0.247	0.279	0.274	0.279	0.270	0.279
27-4	0.245	0.245	0.245	0.267	0.243	0.262	0.254	0.254	0.270	0.262	0.271	0.262	0.270	0.262	0.262	0.270	0.262	0.262	0.274	0.274	0.274	0.270	0.266	0.274	0.243	0.243	0.243	0.243	0.243	0.279	0.274	0.279	0.270	0.279
27-5	0.245	0.245	0.245	0.267	0.243	0.262	0.254	0.254	0.270	0.262	0.271	0.262	0.270	0.262	0.262	0.270	0.262	0.262	0.274	0.274	0.274	0.270	0.266	0.274	0.243	0.243	0.243	0.243	0.243	0.279	0.274	0.279	0.270	0.279
27-6	0.245	0.245	0.245	0.263	0.255	0.267	0.258	0.258	0.274	0.266	0.263	0.254	0.262	0.254	0.254	0.262	0.254	0.254	0.266	0.266	0.266	0.262	0.258	0.266	0.235	0.235	0.235	0.235	0.235	0.270	0.266	0.270	0.262	0.270
28-1	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-2	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-3	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-4	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-5	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-6	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-7	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-8	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-9	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-10	0.292	0.292	0.292	0.275	0.288	0.293	0.307	0.307	0.263	0.255	0.282	0.287	0.295	0.287	0.287	0.295	0.287	0.287	0.291	0.295	0.295	0.295	0.291	0.295	0.291	0.291	0.291	0.291	0.291	0.295	0.295	0.295	0.295	0.295
28-11	0.288	0.288	0.288	0.271	0.283	0.289	0.302	0.302	0.259	0.251	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-12	0.283	0.283	0.283	0.275	0.296	0.293	0.307	0.307	0.263	0.255	0.274	0.278	0.287	0.278	0.278	0.287	0.278	0.278	0.282	0.287	0.287	0.287	0.282	0.287	0.283	0.283	0.283	0.283	0.283	0.287	0.287	0.287	0.287	0.287
28-13	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-14	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-15	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-16	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-17	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-18	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-19	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-20	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-21	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-22	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
28-23	0.283	0.283	0.283	0.267	0.283	0.293	0.307	0.307	0.263	0.255	0.278	0.282	0.291	0.282	0.282	0.291	0.282	0.282	0.287	0.291	0.291	0.291	0.287	0.291	0.287	0.287	0.287	0.287	0.287	0.291	0.291	0.291	0.291	0.291
29-1	0.253	0.253	0.253	0.246	0.254	0.272	0.264	0.264	0.282	0.269	0.185	0.196	0.189	0.196	0.196	0.189	0.196	0.196	0.192	0.192	0.192	0.189	0.192	0.192	0.188	0.188	0.188	0.188	0.188	0.196	0.192	0.196	0.189	0.196
29-2	0.253	0.253	0.253	0.246	0.254	0.272	0.264	0.264	0.282	0.269	0.185	0.196	0.189	0.196	0.196	0.189	0.196	0.196	0.192	0.192	0.192	0.189	0.192	0.192	0.188	0.188	0.188	0.188	0.188	0.196	0.192	0.196	0.189	0.196
29-3	0.253	0.253	0.253	0.246	0.254	0.272	0.264	0.264	0.282	0.269	0.185	0.196	0.189	0.196	0.196	0.189	0.196	0.196	0.192	0.192	0.192	0.189	0.192	0.192	0.188	0.188	0.188	0.188	0.188	0.196	0.192	0.196	0.189	0.196
30-1	0.240	0.240	0.240	0.288	0.251	0.236	0.240	0.240	0.271	0.263	0.286	0.294	0.294	0.294	0.294	0.294	0.294	0.294	0.298	0.294	0.294	0.294	0.290	0.294	0.278	0.278	0.278	0.278	0.278	0.294	0.294	0.294	0.294	0.294
30-2	0.240	0.240	0.240	0.288	0.251	0.236	0.240	0.240	0.271	0.263	0.286	0.294	0.294	0.294	0.294	0.294	0.294	0.294	0.298	0.294	0.294	0.294	0.290	0.294	0.278	0.278	0.278	0.278	0.278	0.294	0.294	0.294	0.294	0.294

Table 1. Continued.

	6-25	6-26	6-27	6-28	6-29	6-30	6-31	6-32	6-33	6-34	6-35	6-36	6-37	7-1	7-2	7-3	7-4	7-5	7-6	7-7	7-8	8-1	8-2	8-3	8-4	8-5	8-6	8-7	8-8	8-9	8-10	8-11	9-1	9-2
27-1	0.274	0.274	0.266	0.258	0.262	0.258	0.258	0.258	0.274	0.270	0.274	0.271	0.271	0.250	0.262	0.239	0.254	0.250	0.250	0.242	0.250	0.278	0.278	0.278	0.278	0.274	0.278	0.278	0.274	0.278	0.278	0.274	0.262	0.262
27-2	0.270	0.270	0.262	0.254	0.258	0.254	0.254	0.254	0.270	0.266	0.270	0.267	0.267	0.246	0.258	0.235	0.250	0.246	0.247	0.239	0.247	0.270	0.270	0.270	0.270	0.266	0.270	0.270	0.266	0.270	0.270	0.266	0.251	0.251
27-3	0.279	0.279	0.270	0.262	0.266	0.262	0.262	0.262	0.279	0.274	0.279	0.267	0.267	0.254	0.266	0.242	0.258	0.254	0.254	0.246	0.254	0.282	0.282	0.282	0.282	0.278	0.282	0.282	0.278	0.282	0.282	0.278	0.262	0.262
27-4	0.279	0.279	0.270	0.262	0.266	0.262	0.262	0.262	0.279	0.274	0.279	0.275	0.275	0.246	0.250	0.235	0.243	0.246	0.239	0.239	0.239	0.278	0.278	0.278	0.278	0.274	0.278	0.278	0.274	0.278	0.278	0.274	0.259	0.259
27-5	0.279	0.279	0.270	0.262	0.266	0.262	0.262	0.262	0.279	0.274	0.279	0.275	0.275	0.246	0.250	0.235	0.243	0.246	0.239	0.239	0.239	0.278	0.278	0.278	0.278	0.274	0.278	0.278	0.274	0.278	0.278	0.274	0.259	0.259
27-6	0.270	0.270	0.262	0.254	0.258	0.254	0.254	0.254	0.270	0.266	0.270	0.267	0.267	0.243	0.254	0.231	0.246	0.243	0.243	0.235	0.243	0.274	0.274	0.274	0.274	0.270	0.274	0.274	0.270	0.274	0.274	0.270	0.259	0.259
28-1	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-2	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-3	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-4	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-5	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-6	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-7	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-8	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-9	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-10	0.295	0.295	0.299	0.287	0.291	0.287	0.287	0.287	0.295	0.295	0.295	0.282	0.287	0.258	0.262	0.262	0.270	0.254	0.271	0.258	0.271	0.276	0.280	0.276	0.276	0.271	0.288	0.288	0.276	0.276	0.276	0.276	0.251	0.251
28-11	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.271	0.276	0.271	0.271	0.267	0.284	0.284	0.271	0.271	0.271	0.271	0.247	0.247
28-12	0.287	0.287	0.291	0.278	0.282	0.278	0.278	0.278	0.287	0.287	0.287	0.274	0.278	0.258	0.262	0.262	0.270	0.254	0.271	0.258	0.271	0.284	0.288	0.284	0.284	0.280	0.296	0.296	0.284	0.284	0.284	0.284	0.251	0.251
28-13	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-14	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-15	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-16	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-17	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-18	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-19	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-20	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-21	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-22	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
28-23	0.291	0.291	0.295	0.282	0.287	0.282	0.282	0.282	0.291	0.291	0.291	0.278	0.282	0.254	0.258	0.258	0.266	0.250	0.267	0.254	0.267	0.280	0.284	0.280	0.280	0.276	0.292	0.292	0.280	0.280	0.280	0.280	0.243	0.243
29-1	0.196	0.196	0.189	0.196	0.200	0.196	0.196	0.196	0.196	0.192	0.200	0.189	0.189	0.222	0.225	0.226	0.218	0.218	0.218	0.222	0.218	0.231	0.231	0.231	0.231	0.227	0.235	0.235	0.227	0.231	0.231	0.231	0.203	0.203
29-2	0.196	0.196	0.189	0.196	0.200	0.196	0.196	0.196	0.196	0.192	0.200	0.189	0.189	0.222	0.225	0.226	0.218	0.218	0.218	0.222	0.218	0.231	0.231	0.231	0.231	0.227	0.235	0.235	0.227	0.231	0.231	0.231	0.203	0.203
29-3	0.196	0.196	0.189	0.196	0.200	0.196	0.196	0.196	0.196	0.192	0.200	0.189	0.189	0.222	0.225	0.226	0.218	0.218	0.218	0.222	0.218	0.231	0.231	0.231	0.231	0.227	0.235	0.235	0.227	0.231	0.231	0.231	0.203	0.203
30-1	0.294	0.294	0.294	0.294	0.298	0.294	0.294	0.294	0.294	0.294	0.294	0.286	0.286	0.302	0.290	0.298	0.298	0.290	0.298	0.302	0.298	0.302	0.302	0.302	0.302	0.298	0.311	0.311	0.302	0.302	0.302	0.302	0.255	0.255
30-2	0.294	0.294	0.294	0.294	0.298	0.294	0.294	0.294	0.294	0.294	0.294	0.286	0.286	0.302	0.290	0.298	0.298	0.290	0.298	0.302	0.298	0.302	0.302	0.302	0.302	0.298	0.311	0.311	0.302	0.302	0.302	0.302	0.255	0.255

Table 1. Continued.

	9-3	9-4	9-5	9-6	9-7	9-8	9-9	10-1	11-1	11-2	11-3	12-1	13-1	13-2	13-3	13-4	13-5	14-1	14-2	14-3	14-4	14-5	14-6	15-1	15-2	16-1	16-2	16-3	17-1	17-2	17-3	18-1	18-2	18-3
27-1	0.262	0.262	0.262	0.262	0.262	0.262	0.262	0.279	0.287	0.287	0.287	0.295	0.240	0.240	0.240	0.240	0.236	0.268	0.272	0.272	0.272	0.272	0.272	0.251	0.251	0.249	0.245	0.249	0.285	0.285	0.285	0.276	0.276	0.272
27-2	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.270	0.279	0.279	0.279	0.291	0.228	0.228	0.228	0.228	0.225	0.264	0.268	0.268	0.268	0.268	0.268	0.247	0.247	0.241	0.237	0.241	0.269	0.269	0.269	0.264	0.264	0.260
27-3	0.262	0.262	0.262	0.262	0.262	0.262	0.262	0.279	0.287	0.287	0.287	0.300	0.240	0.240	0.240	0.240	0.236	0.268	0.272	0.272	0.272	0.272	0.272	0.251	0.251	0.253	0.249	0.253	0.285	0.285	0.285	0.280	0.280	0.276
27-4	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.279	0.287	0.287	0.287	0.300	0.236	0.236	0.236	0.236	0.232	0.272	0.276	0.276	0.276	0.276	0.276	0.240	0.240	0.241	0.237	0.241	0.277	0.277	0.277	0.272	0.272	0.268
27-5	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.279	0.287	0.287	0.287	0.300	0.236	0.236	0.236	0.236	0.232	0.272	0.276	0.276	0.276	0.276	0.276	0.240	0.240	0.241	0.237	0.241	0.277	0.277	0.277	0.272	0.272	0.268
27-6	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.274	0.283	0.283	0.283	0.291	0.240	0.240	0.240	0.240	0.236	0.272	0.276	0.276	0.276	0.276	0.276	0.251	0.251	0.245	0.241	0.245	0.281	0.281	0.281	0.276	0.276	0.272
28-1	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-2	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-3	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-4	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-5	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-6	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-7	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-8	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-9	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-10	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.273	0.275	0.275	0.275	0.277	0.276	0.276	0.276	0.276	0.271	0.302	0.298	0.302	0.298	0.298	0.298	0.295	0.295	0.277	0.269	0.286	0.294	0.294	0.294	0.322	0.322	0.318
28-11	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.269	0.279	0.279	0.279	0.273	0.271	0.271	0.271	0.271	0.267	0.307	0.302	0.307	0.302	0.302	0.302	0.291	0.291	0.273	0.265	0.281	0.289	0.289	0.289	0.317	0.317	0.313
28-12	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.265	0.275	0.275	0.275	0.277	0.284	0.284	0.284	0.284	0.280	0.311	0.307	0.311	0.307	0.307	0.307	0.295	0.295	0.277	0.269	0.286	0.294	0.294	0.294	0.322	0.322	0.318
28-13	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-14	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-15	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-16	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-17	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-18	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-19	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-20	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-21	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-22	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
28-23	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.273	0.275	0.275	0.275	0.282	0.271	0.271	0.271	0.271	0.267	0.298	0.293	0.298	0.293	0.293	0.293	0.300	0.300	0.277	0.269	0.286	0.298	0.298	0.298	0.322	0.322	0.318
29-1	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.245	0.248	0.248	0.248	0.212	0.308	0.308	0.308	0.308	0.304	0.283	0.283	0.283	0.283	0.283	0.283	0.302	0.302	0.272	0.285	0.264	0.268	0.268	0.268	0.265	0.265	0.265
29-2	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.245	0.248	0.248	0.248	0.212	0.308	0.308	0.308	0.308	0.304	0.283	0.283	0.283	0.283	0.283	0.283	0.302	0.302	0.272	0.285	0.264	0.268	0.268	0.268	0.265	0.265	0.265
29-3	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.245	0.248	0.248	0.248	0.212	0.308	0.308	0.308	0.308	0.304	0.283	0.283	0.283	0.283	0.283	0.283	0.302	0.302	0.272	0.285	0.264	0.268	0.268	0.268	0.265	0.265	0.265
30-1	0.255	0.255	0.255	0.255	0.255	0.255	0.255	0.229	0.251	0.251	0.251	0.244	0.255	0.255	0.255	0.255	0.251	0.264	0.259	0.264	0.259	0.259	0.259	0.265	0.265	0.233	0.229	0.233	0.260	0.260	0.248	0.303	0.303	0.299
30-2	0.255	0.255	0.255	0.255	0.255	0.255	0.255	0.229	0.251	0.251	0.251	0.244	0.255	0.255	0.255	0.255	0.251	0.264	0.259	0.264	0.259	0.259	0.259	0.265	0.265	0.233	0.229	0.233	0.260	0.260	0.248	0.303	0.303	0.299

Table 1. Continued.

	18-4	18-5	19-1	19-2	19-3	19-4	19-5	19-6	19-7	20-1	20-2	20-3	20-4	20-5	20-6	20-7	20-8	21-1	21-2	22-1	23-1	23-2	24-1	24-2	24-3	25-1	25-2	25-3	26-1	26-2	26-3	25-4	25-5	25-6
27-1	0.276	0.276	0.253	0.249	0.249	0.249	0.249	0.249	0.249	0.256	0.256	0.256	0.256	0.256	0.256	0.256	0.252	0.269	0.269	0.291	0.276	0.276	0.273	0.273	0.273	0.237	0.237	0.237	0.212	0.212	0.212	0.237	0.237	0.237
27-2	0.264	0.264	0.238	0.234	0.234	0.234	0.234	0.234	0.234	0.248	0.248	0.248	0.248	0.248	0.248	0.248	0.244	0.265	0.265	0.284	0.268	0.268	0.269	0.269	0.269	0.233	0.233	0.233	0.215	0.215	0.215	0.233	0.233	0.233
27-3	0.280	0.280	0.257	0.253	0.253	0.253	0.253	0.253	0.253	0.256	0.256	0.256	0.256	0.256	0.256	0.256	0.252	0.269	0.269	0.291	0.276	0.276	0.273	0.273	0.273	0.237	0.237	0.237	0.212	0.212	0.212	0.237	0.237	0.237
27-4	0.272	0.272	0.246	0.242	0.242	0.242	0.242	0.242	0.242	0.256	0.256	0.256	0.256	0.256	0.256	0.256	0.252	0.265	0.265	0.284	0.276	0.276	0.277	0.277	0.277	0.241	0.241	0.241	0.223	0.223	0.223	0.241	0.241	0.241
27-5	0.272	0.272	0.246	0.242	0.242	0.242	0.242	0.242	0.242	0.256	0.256	0.256	0.256	0.256	0.256	0.256	0.252	0.265	0.265	0.284	0.276	0.276	0.277	0.277	0.277	0.241	0.241	0.241	0.223	0.223	0.223	0.241	0.241	0.241
27-6	0.276	0.276	0.250	0.246	0.246	0.246	0.246	0.246	0.246	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.240	0.269	0.269	0.284	0.272	0.272	0.277	0.277	0.277	0.241	0.241	0.241	0.215	0.215	0.215	0.241	0.241	0.241
28-1	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-2	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-3	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-4	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-5	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-6	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-7	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-8	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-9	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-10	0.322	0.322	0.289	0.293	0.293	0.293	0.293	0.293	0.293	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.249	0.290	0.290	0.315	0.257	0.257	0.237	0.233	0.237	0.261	0.261	0.261	0.231	0.231	0.231	0.261	0.261	0.261
28-11	0.317	0.317	0.285	0.289	0.289	0.289	0.289	0.289	0.289	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.233	0.229	0.233	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-12	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.261	0.261	0.261	0.261	0.261	0.261	0.261	0.257	0.290	0.290	0.315	0.265	0.265	0.237	0.233	0.237	0.261	0.261	0.261	0.239	0.239	0.239	0.261	0.261	0.261
28-13	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-14	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-15	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-16	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-17	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-18	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-19	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-20	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-21	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-22	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
28-23	0.322	0.322	0.280	0.285	0.285	0.285	0.285	0.285	0.285	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.295	0.295	0.310	0.253	0.253	0.241	0.237	0.241	0.257	0.257	0.257	0.235	0.235	0.235	0.257	0.257	0.257
29-1	0.265	0.265	0.284	0.280	0.280	0.280	0.280	0.280	0.280	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.291	0.291	0.237	0.286	0.286	0.215	0.218	0.215	0.213	0.213	0.213	0.226	0.226	0.226	0.213	0.213	0.213
29-2	0.265	0.265	0.284	0.280	0.280	0.280	0.280	0.280	0.280	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.291	0.291	0.237	0.286	0.286	0.211	0.215	0.211	0.217	0.217	0.217	0.226	0.226	0.226	0.217	0.217	0.217
29-3	0.265	0.265	0.284	0.280	0.280	0.280	0.280	0.280	0.280	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.291	0.291	0.237	0.286	0.286	0.215	0.218	0.215	0.213	0.213	0.213	0.226	0.226	0.226	0.213	0.213	0.213
30-1	0.303	0.303	0.279	0.275	0.275	0.275	0.275	0.275	0.275	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.236	0.298	0.298	0.237	0.264	0.264	0.218	0.222	0.218	0.226	0.226	0.226	0.227	0.227	0.227	0.226	0.226	0.226
30-2	0.303	0.303	0.279	0.275	0.275	0.275	0.275	0.275	0.275	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.236	0.298	0.298	0.237	0.264	0.264	0.218	0.222	0.218	0.226	0.226	0.226	0.227	0.227	0.227	0.226	0.226	0.226

Table 1. Continued.

	27-1	27-2	27-3	27-4	27-5	27-6	28-1	28-2	28-3	28-4	28-5	28-6	28-7	28-8	28-9	28-10	28-11	28-12	28-13	28-14	28-15	28-16	28-17	28-18	28-19	28-20	28-21	28-22	28-23	29-1	29-2	29-3	30-1	30-2
27-1																																		
27-2	0.011																																	
27-3	0.003	0.014																																
27-4	0.011	0.005	0.014																															
27-5	0.011	0.005	0.014	0.000																														
27-6	0.008	0.008	0.011	0.008	0.008																													
28-1	0.238	0.234	0.238	0.234	0.234	0.238																												
28-2	0.238	0.234	0.238	0.234	0.234	0.238	0.000																											
28-3	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000																										
28-4	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000																									
28-5	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000																								
28-6	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000																							
28-7	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000	0.000																						
28-8	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.000																					
28-9	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																				
28-10	0.238	0.234	0.238	0.234	0.234	0.238	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008																			
28-11	0.234	0.230	0.234	0.230	0.230	0.234	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.003																		
28-12	0.246	0.242	0.246	0.242	0.242	0.246	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.005	0.008																	
28-13	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.011	0.008																
28-14	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.011	0.008	0.000															
28-15	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.011	0.008	0.000	0.000														
28-16	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.011	0.008	0.000	0.000	0.000													
28-17	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.011	0.008	0.000	0.000	0.000	0.000												
28-18	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.011	0.008	0.000	0.000	0.000	0.000	0.000											
28-19	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.011	0.008	0.000	0.000	0.000	0.000	0.000	0.000										
28-20	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.011	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000									
28-21	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.011	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000								
28-22	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.011	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000							
28-23	0.238	0.234	0.238	0.234	0.234	0.238	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.011	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000						
29-1	0.236	0.232	0.236	0.239	0.239	0.232	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.262	0.257	0.270	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266					
29-2	0.232	0.228	0.232	0.236	0.236	0.228	0.262	0.262	0.262	0.262	0.262	0.262	0.262	0.262	0.262	0.257	0.253	0.266	0.262	0.262	0.262	0.262	0.262	0.262	0.262	0.262	0.262	0.262	0.262	0.003				
29-3	0.236	0.232	0.236	0.239	0.239	0.232	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.262	0.257	0.270	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.000	0.003			
30-1	0.222	0.215	0.222	0.207	0.207	0.219	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.168	0.164	0.161	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.207	0.203	0.207		
30-2	0.222	0.215	0.222	0.207	0.207	0.219	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.168	0.164	0.161	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.207	0.203	0.207	0.000	

Table 1. Continued.

	1-1	1-2	1-3	2-1	3-1	4-1	4-2	4-3	5-1	5-2	6-1	6-2	6-3	6-4	6-5	6-6	6-7	6-8	6-9	6-10	6-11	6-12	6-13	6-14	6-15	6-16	6-17	6-18	6-19	6-20	6-21	6-22	6-23	6-24
30-3	0.240	0.240	0.240	0.288	0.251	0.236	0.240	0.240	0.271	0.263	0.286	0.294	0.294	0.294	0.294	0.294	0.294	0.294	0.298	0.294	0.294	0.294	0.290	0.294	0.278	0.278	0.278	0.278	0.278	0.294	0.294	0.294	0.294	0.294
30-4	0.240	0.240	0.240	0.288	0.251	0.236	0.240	0.240	0.271	0.263	0.286	0.294	0.294	0.294	0.294	0.294	0.294	0.294	0.298	0.294	0.294	0.294	0.290	0.294	0.278	0.278	0.278	0.278	0.278	0.294	0.294	0.294	0.294	0.294
31-1	0.287	0.287	0.287	0.242	0.271	0.298	0.290	0.290	0.216	0.208	0.208	0.211	0.211	0.211	0.211	0.211	0.211	0.211	0.215	0.215	0.215	0.211	0.207	0.207	0.219	0.219	0.219	0.219	0.219	0.211	0.215	0.211	0.211	0.211
31-2	0.296	0.296	0.296	0.242	0.271	0.298	0.290	0.290	0.224	0.216	0.208	0.211	0.211	0.211	0.211	0.211	0.211	0.211	0.215	0.215	0.215	0.211	0.207	0.207	0.219	0.219	0.219	0.219	0.219	0.211	0.215	0.211	0.211	0.211
31-3	0.291	0.291	0.291	0.246	0.267	0.302	0.294	0.294	0.220	0.212	0.212	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.219	0.219	0.219	0.215	0.211	0.211	0.223	0.223	0.223	0.223	0.223	0.215	0.219	0.215	0.215	0.215
32-1	0.235	0.235	0.235	0.236	0.249	0.231	0.231	0.231	0.266	0.250	0.239	0.243	0.250	0.243	0.243	0.250	0.243	0.243	0.254	0.254	0.254	0.250	0.247	0.247	0.228	0.228	0.228	0.228	0.228	0.250	0.254	0.250	0.250	0.250
32-2	0.239	0.239	0.239	0.232	0.241	0.231	0.231	0.231	0.262	0.246	0.235	0.239	0.247	0.239	0.239	0.247	0.239	0.239	0.250	0.250	0.250	0.247	0.243	0.243	0.224	0.224	0.224	0.224	0.224	0.247	0.250	0.247	0.247	0.247
33-1	0.247	0.247	0.247	0.221	0.274	0.271	0.276	0.276	0.232	0.221	0.235	0.246	0.239	0.246	0.246	0.239	0.246	0.246	0.243	0.239	0.239	0.239	0.235	0.243	0.228	0.228	0.228	0.228	0.228	0.243	0.239	0.243	0.239	0.243
33-2	0.251	0.251	0.251	0.236	0.275	0.268	0.272	0.272	0.202	0.199	0.247	0.247	0.239	0.247	0.247	0.239	0.247	0.247	0.235	0.239	0.239	0.239	0.235	0.243	0.224	0.224	0.224	0.224	0.224	0.243	0.239	0.243	0.239	0.243
33-3	0.251	0.251	0.251	0.228	0.270	0.259	0.255	0.255	0.217	0.206	0.231	0.250	0.243	0.250	0.250	0.243	0.250	0.250	0.247	0.243	0.243	0.243	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.243	0.239	0.243	0.239
33-4	0.264	0.264	0.264	0.232	0.274	0.259	0.255	0.255	0.199	0.195	0.231	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.247	0.243	0.243	0.243	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.243	0.239	0.243	0.239
33-5	0.244	0.244	0.244	0.232	0.267	0.260	0.264	0.264	0.206	0.202	0.236	0.235	0.228	0.235	0.235	0.228	0.235	0.235	0.231	0.228	0.228	0.228	0.224	0.231	0.213	0.213	0.213	0.213	0.213	0.231	0.228	0.231	0.228	0.231
33-6	0.259	0.259	0.259	0.232	0.278	0.255	0.251	0.251	0.202	0.199	0.228	0.247	0.239	0.247	0.247	0.239	0.247	0.247	0.243	0.239	0.239	0.239	0.235	0.235	0.243	0.243	0.243	0.243	0.243	0.235	0.239	0.235	0.239	0.235
33-7	0.255	0.255	0.255	0.228	0.278	0.255	0.251	0.251	0.202	0.199	0.228	0.247	0.239	0.247	0.247	0.239	0.247	0.247	0.243	0.239	0.239	0.239	0.235	0.235	0.243	0.243	0.243	0.243	0.243	0.235	0.239	0.235	0.239	0.235
33-8	0.255	0.255	0.255	0.228	0.278	0.255	0.251	0.251	0.202	0.199	0.228	0.247	0.239	0.247	0.247	0.239	0.247	0.247	0.243	0.239	0.239	0.239	0.235	0.235	0.243	0.243	0.243	0.243	0.243	0.235	0.239	0.235	0.239	0.235
33-9	0.255	0.255	0.255	0.228	0.278	0.255	0.251	0.251	0.202	0.199	0.228	0.247	0.239	0.247	0.247	0.239	0.247	0.247	0.243	0.239	0.239	0.239	0.235	0.235	0.243	0.243	0.243	0.243	0.243	0.235	0.239	0.235	0.239	0.235
33-10	0.255	0.255	0.255	0.228	0.278	0.255	0.251	0.251	0.202	0.199	0.228	0.247	0.239	0.247	0.247	0.239	0.247	0.247	0.243	0.239	0.239	0.239	0.235	0.235	0.243	0.243	0.243	0.243	0.243	0.235	0.239	0.235	0.239	0.235
33-11	0.255	0.255	0.255	0.228	0.278	0.255	0.251	0.251	0.202	0.199	0.228	0.247	0.239	0.247	0.247	0.239	0.247	0.247	0.243	0.239	0.239	0.239	0.235	0.235	0.243	0.243	0.243	0.243	0.243	0.235	0.239	0.235	0.239	0.235
33-12	0.255	0.255	0.255	0.228	0.278	0.255	0.251	0.251	0.202	0.199	0.228	0.247	0.239	0.247	0.247	0.239	0.247	0.247	0.243	0.239	0.239	0.239	0.235	0.235	0.243	0.243	0.243	0.243	0.243	0.235	0.239	0.235	0.239	0.235
33-13	0.255	0.255	0.255	0.228	0.278	0.255	0.251	0.251	0.202	0.199	0.228	0.247	0.239	0.247	0.247	0.239	0.247	0.247	0.243	0.239	0.239	0.239	0.235	0.235	0.243	0.243	0.243	0.243	0.243	0.235	0.239	0.235	0.239	0.235
33-14	0.264	0.264	0.264	0.232	0.282	0.259	0.259	0.259	0.192	0.188	0.247	0.251	0.258	0.251	0.251	0.258	0.251	0.251	0.262	0.255	0.255	0.258	0.255	0.255	0.247	0.247	0.247	0.247	0.247	0.251	0.255	0.251	0.258	0.251
33-15	0.264	0.264	0.264	0.232	0.282	0.259	0.259	0.259	0.192	0.188	0.247	0.251	0.258	0.251	0.251	0.258	0.251	0.251	0.262	0.255	0.255	0.258	0.255	0.255	0.247	0.247	0.247	0.247	0.247	0.251	0.255	0.251	0.258	0.251
33-16	0.247	0.247	0.247	0.228	0.271	0.264	0.268	0.268	0.202	0.199	0.239	0.239	0.231	0.239	0.239	0.231	0.239	0.239	0.235	0.231	0.231	0.231	0.228	0.235	0.217	0.217	0.217	0.217	0.217	0.235	0.231	0.235	0.231	0.235
33-17	0.244	0.244	0.244	0.224	0.271	0.264	0.268	0.268	0.206	0.202	0.236	0.235	0.228	0.235	0.235	0.228	0.235	0.235	0.231	0.228	0.228	0.228	0.224	0.231	0.220	0.220	0.220	0.220	0.220	0.231	0.228	0.231	0.228	0.231
33-18	0.251	0.251	0.251	0.224	0.275	0.268	0.272	0.272	0.199	0.195	0.236	0.235	0.228	0.235	0.235	0.228	0.235	0.235	0.231	0.228	0.228	0.228	0.224	0.231	0.220	0.220	0.220	0.220	0.220	0.231	0.228	0.231	0.228	0.231
33-19	0.255	0.255	0.255	0.228	0.271	0.256	0.260	0.260	0.206	0.202	0.239	0.247	0.239	0.247	0.247	0.239	0.247	0.247	0.243	0.239	0.239	0.239	0.235	0.243	0.224	0.224	0.224	0.224	0.224	0.243	0.239	0.243	0.239	0.243
33-20	0.255	0.255	0.255	0.228	0.271	0.264	0.268	0.268	0.202	0.199	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.235	0.239	0.239	0.239	0.235	0.235	0.217	0.217	0.217	0.217	0.217	0.235	0.239	0.235	0.239	0.235
33-21	0.247	0.247	0.247	0.221	0.274	0.271	0.276	0.276	0.232	0.221	0.235	0.246	0.239	0.246	0.246	0.239	0.246	0.246	0.243	0.239	0.239	0.239	0.235	0.243	0.228	0.228	0.228	0.228	0.228	0.243	0.239	0.243	0.239	0.243
33-22	0.255	0.255	0.255	0.228	0.282	0.280	0.284	0.284	0.224	0.213	0.235	0.246	0.239	0.246	0.246	0.239	0.246	0.246	0.243	0.239	0.239	0.239	0.235	0.243	0.228	0.228	0.228	0.228	0.228	0.243	0.239	0.243	0.239	0.243
33-23	0.247	0.247	0.247	0.221	0.274	0.271	0.276	0.276	0.232	0.221	0.235	0.246	0.239	0.246	0.246	0.239	0.246	0.246	0.243	0.239	0.239	0.239	0.235	0.243	0.228	0.228	0.228	0.228	0.228	0.243	0.239	0.243	0.239	0.243
33-24	0.247	0.247	0.247	0.221	0.274	0.271	0.276	0.276	0.232	0.221	0.235	0.246	0.239	0.246	0.246	0.239	0.246	0.246	0.243	0.239	0.239	0.239	0.235	0.243	0.228	0.228	0.228	0.228	0.228	0.243	0.239	0.243	0.239	0.243
33-25	0.259	0.259	0.259	0.232	0.291	0.288	0.284	0.284	0.232	0.221	0.235	0.243	0.235	0.243	0.243	0.235	0.243	0.243	0.239	0.235	0.235	0.235	0.231	0.239	0.224	0.224	0.224	0.224	0.224	0.239	0.235	0.239	0.235	0.239
34-1	0.297	0.297	0.297	0.260	0.257	0.277	0.285	0.285	0.218	0.230	0.229	0.232	0.224	0.232	0.232	0.224	0.232	0.232	0.228	0.228	0.228	0.224	0.228	0.228	0.225	0.225	0.225	0.225	0.225	0.232	0.228	0.232	0.224	0.232
35-1	0.307	0.307	0.307	0.262	0.277	0.241	0.237	0.237	0.240	0.228	0.231	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.250	0.247	0.247	0.247	0.250	0.247	0.239	0.239	0.239	0.239	0.239	0.247	0.247	0.247	0.247	0.247

Table 1. Continued.

	6-25	6-26	6-27	6-28	6-29	6-30	6-31	6-32	6-33	6-34	6-35	6-36	6-37	7-1	7-2	7-3	7-4	7-5	7-6	7-7	7-8	8-1	8-2	8-3	8-4	8-5	8-6	8-7	8-8	8-9	8-10	8-11	9-1	9-2
30-3	0.294	0.294	0.294	0.294	0.298	0.294	0.294	0.294	0.294	0.294	0.294	0.286	0.286	0.302	0.290	0.298	0.298	0.290	0.298	0.302	0.298	0.302	0.302	0.302	0.302	0.298	0.311	0.311	0.302	0.302	0.302	0.302	0.255	0.255
30-4	0.294	0.294	0.294	0.294	0.298	0.294	0.294	0.294	0.294	0.294	0.294	0.286	0.286	0.302	0.290	0.298	0.298	0.290	0.298	0.302	0.298	0.302	0.302	0.302	0.302	0.298	0.311	0.311	0.302	0.302	0.302	0.302	0.255	0.255
31-1	0.211	0.211	0.215	0.211	0.215	0.211	0.211	0.211	0.211	0.211	0.211	0.212	0.215	0.235	0.246	0.235	0.239	0.243	0.242	0.239	0.242	0.212	0.216	0.212	0.212	0.208	0.219	0.219	0.220	0.216	0.212	0.212	0.193	0.193
31-2	0.211	0.211	0.215	0.211	0.215	0.211	0.211	0.211	0.211	0.211	0.211	0.212	0.215	0.235	0.238	0.235	0.231	0.243	0.234	0.239	0.234	0.212	0.216	0.212	0.212	0.208	0.219	0.219	0.220	0.216	0.212	0.212	0.193	0.193
31-3	0.215	0.215	0.219	0.215	0.219	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.219	0.239	0.242	0.239	0.235	0.247	0.238	0.243	0.238	0.216	0.220	0.216	0.216	0.212	0.223	0.223	0.223	0.220	0.216	0.216	0.197	0.197
32-1	0.250	0.250	0.254	0.243	0.247	0.243	0.243	0.243	0.250	0.247	0.250	0.243	0.247	0.268	0.264	0.268	0.264	0.260	0.268	0.264	0.268	0.259	0.259	0.259	0.259	0.255	0.259	0.259	0.268	0.264	0.259	0.264	0.214	0.214
32-2	0.247	0.247	0.250	0.239	0.243	0.239	0.239	0.239	0.247	0.243	0.247	0.239	0.243	0.260	0.256	0.260	0.256	0.252	0.260	0.256	0.260	0.255	0.255	0.255	0.255	0.251	0.255	0.255	0.264	0.259	0.255	0.259	0.210	0.210
33-1	0.243	0.243	0.243	0.246	0.250	0.246	0.246	0.246	0.243	0.243	0.246	0.235	0.239	0.221	0.217	0.225	0.225	0.210	0.225	0.221	0.225	0.248	0.248	0.248	0.248	0.244	0.255	0.255	0.244	0.248	0.248	0.248	0.217	0.217
33-2	0.243	0.243	0.235	0.247	0.251	0.247	0.247	0.247	0.243	0.243	0.247	0.247	0.243	0.221	0.218	0.225	0.225	0.210	0.221	0.221	0.221	0.236	0.240	0.236	0.236	0.232	0.244	0.244	0.232	0.236	0.236	0.236	0.236	0.236
33-3	0.239	0.239	0.247	0.250	0.254	0.250	0.250	0.250	0.239	0.239	0.243	0.231	0.235	0.225	0.241	0.221	0.237	0.229	0.237	0.225	0.237	0.244	0.247	0.244	0.244	0.240	0.251	0.251	0.247	0.244	0.244	0.244	0.251	0.251
33-4	0.239	0.239	0.247	0.243	0.247	0.243	0.243	0.243	0.239	0.239	0.243	0.231	0.235	0.225	0.237	0.217	0.233	0.225	0.233	0.221	0.233	0.244	0.252	0.244	0.244	0.240	0.252	0.252	0.248	0.244	0.244	0.240	0.247	0.247
33-5	0.231	0.231	0.224	0.235	0.239	0.235	0.235	0.235	0.231	0.231	0.235	0.236	0.232	0.214	0.210	0.217	0.217	0.203	0.214	0.214	0.214	0.228	0.232	0.228	0.228	0.225	0.236	0.236	0.225	0.228	0.228	0.228	0.232	0.232
33-6	0.235	0.235	0.243	0.247	0.251	0.247	0.247	0.247	0.235	0.235	0.239	0.228	0.232	0.221	0.237	0.217	0.232	0.225	0.233	0.221	0.233	0.240	0.244	0.240	0.240	0.236	0.247	0.247	0.244	0.240	0.240	0.236	0.251	0.251
33-7	0.235	0.235	0.243	0.247	0.251	0.247	0.247	0.247	0.235	0.235	0.239	0.228	0.232	0.225	0.241	0.221	0.236	0.229	0.237	0.225	0.237	0.240	0.244	0.240	0.240	0.236	0.247	0.247	0.244	0.240	0.240	0.236	0.251	0.251
33-8	0.235	0.235	0.243	0.247	0.251	0.247	0.247	0.247	0.235	0.235	0.239	0.228	0.232	0.225	0.241	0.221	0.236	0.229	0.237	0.225	0.237	0.240	0.244	0.240	0.240	0.236	0.247	0.247	0.244	0.240	0.240	0.236	0.251	0.251
33-9	0.235	0.235	0.243	0.247	0.251	0.247	0.247	0.247	0.235	0.235	0.239	0.228	0.232	0.225	0.241	0.221	0.236	0.229	0.237	0.225	0.237	0.240	0.244	0.240	0.240	0.236	0.247	0.247	0.244	0.240	0.240	0.236	0.251	0.251
33-10	0.235	0.235	0.243	0.247	0.251	0.247	0.247	0.247	0.235	0.235	0.239	0.228	0.232	0.225	0.241	0.221	0.236	0.229	0.237	0.225	0.237	0.240	0.244	0.240	0.240	0.236	0.247	0.247	0.244	0.240	0.240	0.236	0.251	0.251
33-11	0.235	0.235	0.243	0.247	0.251	0.247	0.247	0.247	0.235	0.235	0.239	0.228	0.232	0.225	0.241	0.221	0.236	0.229	0.237	0.225	0.237	0.240	0.244	0.240	0.240	0.236	0.247	0.247	0.244	0.240	0.240	0.236	0.251	0.251
33-12	0.235	0.235	0.243	0.247	0.251	0.247	0.247	0.247	0.235	0.235	0.239	0.228	0.232	0.225	0.241	0.221	0.236	0.229	0.237	0.225	0.237	0.240	0.244	0.240	0.240	0.236	0.247	0.247	0.244	0.240	0.240	0.236	0.251	0.251
33-13	0.235	0.235	0.243	0.247	0.251	0.247	0.247	0.247	0.235	0.235	0.239	0.228	0.232	0.225	0.241	0.221	0.236	0.229	0.237	0.225	0.237	0.240	0.244	0.240	0.240	0.236	0.247	0.247	0.244	0.240	0.240	0.236	0.251	0.251
33-14	0.251	0.251	0.255	0.251	0.255	0.251	0.251	0.251	0.251	0.255	0.255	0.243	0.239	0.229	0.237	0.241	0.241	0.225	0.241	0.237	0.241	0.236	0.239	0.236	0.236	0.232	0.243	0.243	0.239	0.236	0.236	0.236	0.256	0.256
33-15	0.251	0.251	0.255	0.251	0.255	0.251	0.251	0.251	0.251	0.255	0.255	0.243	0.239	0.229	0.237	0.241	0.241	0.225	0.241	0.237	0.241	0.236	0.239	0.236	0.236	0.232	0.243	0.243	0.239	0.236	0.236	0.236	0.256	0.256
33-16	0.235	0.235	0.228	0.239	0.243	0.239	0.239	0.239	0.235	0.235	0.239	0.239	0.236	0.217	0.214	0.221	0.221	0.206	0.218	0.217	0.218	0.232	0.236	0.232	0.232	0.228	0.240	0.240	0.228	0.232	0.232	0.232	0.236	0.236
33-17	0.231	0.231	0.231	0.235	0.239	0.235	0.235	0.235	0.231	0.231	0.235	0.236	0.239	0.221	0.218	0.225	0.225	0.210	0.221	0.221	0.221	0.236	0.240	0.236	0.236	0.232	0.244	0.244	0.232	0.236	0.236	0.236	0.232	0.232
33-18	0.231	0.231	0.224	0.235	0.239	0.235	0.235	0.235	0.231	0.231	0.235	0.236	0.232	0.214	0.218	0.217	0.225	0.210	0.221	0.214	0.221	0.236	0.240	0.236	0.236	0.232	0.244	0.244	0.232	0.236	0.236	0.236	0.240	0.240
33-19	0.243	0.243	0.235	0.247	0.251	0.247	0.247	0.247	0.243	0.243	0.247	0.239	0.236	0.221	0.218	0.225	0.225	0.210	0.225	0.221	0.225	0.236	0.240	0.236	0.236	0.232	0.244	0.244	0.232	0.236	0.236	0.236	0.228	0.228
33-20	0.235	0.235	0.235	0.239	0.243	0.239	0.239	0.239	0.235	0.235	0.239	0.239	0.236	0.225	0.221	0.229	0.229	0.214	0.225	0.225	0.225	0.232	0.236	0.232	0.232	0.228	0.240	0.240	0.236	0.232	0.232	0.232	0.244	0.244
33-21	0.243	0.243	0.243	0.246	0.250	0.246	0.246	0.246	0.243	0.243	0.246	0.235	0.239	0.221	0.217	0.225	0.225	0.210	0.225	0.221	0.225	0.248	0.248	0.248	0.248	0.244	0.255	0.255	0.244	0.248	0.248	0.248	0.217	0.217
33-22	0.243	0.243	0.243	0.246	0.250	0.246	0.246	0.246	0.243	0.243	0.246	0.235	0.239	0.221	0.217	0.225	0.225	0.210	0.225	0.221	0.225	0.248	0.248	0.248	0.248	0.244	0.255	0.255	0.244	0.248	0.248	0.248	0.217	0.217
33-23	0.243	0.243	0.243	0.246	0.250	0.246	0.246	0.246	0.243	0.243	0.246	0.235	0.239	0.221	0.217	0.225	0.225	0.210	0.225	0.221	0.225	0.248	0.248	0.248	0.248	0.244	0.255	0.255	0.244	0.248	0.248	0.248	0.217	0.217
33-24	0.243	0.243	0.243	0.246	0.250	0.246	0.246	0.246	0.243	0.243	0.246	0.235	0.239	0.221	0.217	0.225	0.225	0.210	0.225	0.221	0.225	0.248	0.248	0.248	0.248	0.244	0.255	0.255	0.244	0.248	0.248	0.248	0.217	0.217
33-25	0.239	0.239	0.239	0.243	0.246	0.243	0.243	0.243	0.239	0.239	0.243	0.235	0.239	0.213	0.217	0.217	0.217	0.210	0.217	0.213	0.217	0.252	0.252	0.252	0.252	0.248	0.259	0.259	0.248	0.252	0.252	0.252	0.221	0.221
34-1	0.232	0.232	0.228	0.232	0.236	0.232	0.232	0.232	0.232	0.232	0.236	0.232	0.236	0.235	0.239	0.239	0.239	0.224	0.243	0.235	0.243	0.285	0.289	0.285	0.285	0.281	0.285	0.285	0.285	0.289	0.285	0.289	0.217	0.217
35-1	0.247	0.247	0.247	0.247	0.250	0.247	0.247	0.247	0.247	0.250	0.247	0.231	0.231	0.267	0.276	0.271	0.279	0.263	0.283	0.267	0.283	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.275	0.275	0.271	0.275	0.235	0.235

Table 1. Continued.

	9-3	9-4	9-5	9-6	9-7	9-8	9-9	10-1	11-1	11-2	11-3	12-1	13-1	13-2	13-3	13-4	13-5	14-1	14-2	14-3	14-4	14-5	14-6	15-1	15-2	16-1	16-2	16-3	17-1	17-2	17-3	18-1	18-2	18-3
30-3	0.255	0.255	0.255	0.255	0.255	0.255	0.255	0.229	0.251	0.251	0.251	0.244	0.255	0.255	0.255	0.255	0.251	0.264	0.259	0.264	0.259	0.259	0.259	0.265	0.265	0.233	0.229	0.233	0.260	0.260	0.248	0.303	0.303	0.299
30-4	0.255	0.255	0.255	0.255	0.255	0.255	0.255	0.229	0.251	0.251	0.251	0.244	0.255	0.255	0.255	0.255	0.251	0.264	0.259	0.264	0.259	0.259	0.259	0.265	0.265	0.233	0.229	0.233	0.260	0.260	0.248	0.303	0.303	0.299
31-1	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.222	0.245	0.245	0.245	0.222	0.247	0.247	0.247	0.247	0.244	0.300	0.300	0.300	0.300	0.300	0.300	0.271	0.271	0.241	0.245	0.233	0.240	0.240	0.240	0.229	0.229	0.226
31-2	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.222	0.253	0.253	0.253	0.230	0.255	0.255	0.255	0.255	0.251	0.300	0.300	0.300	0.300	0.300	0.300	0.263	0.263	0.249	0.253	0.241	0.240	0.240	0.240	0.229	0.229	0.226
31-3	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.226	0.249	0.249	0.249	0.226	0.251	0.251	0.251	0.251	0.247	0.304	0.304	0.304	0.304	0.304	0.304	0.267	0.267	0.245	0.249	0.237	0.244	0.244	0.244	0.233	0.233	0.230
32-1	0.214	0.214	0.214	0.214	0.214	0.214	0.214	0.243	0.251	0.251	0.251	0.228	0.223	0.223	0.223	0.223	0.219	0.285	0.281	0.281	0.281	0.281	0.281	0.270	0.270	0.254	0.254	0.254	0.234	0.234	0.222	0.244	0.244	0.240
32-2	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.235	0.251	0.251	0.251	0.232	0.219	0.219	0.219	0.219	0.215	0.281	0.277	0.277	0.277	0.277	0.277	0.270	0.270	0.250	0.250	0.250	0.234	0.234	0.222	0.244	0.244	0.240
33-1	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.247	0.217	0.217	0.217	0.224	0.258	0.258	0.258	0.258	0.254	0.321	0.321	0.321	0.321	0.321	0.321	0.271	0.271	0.270	0.274	0.270	0.264	0.264	0.255	0.316	0.316	0.312
33-2	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.239	0.225	0.225	0.225	0.206	0.262	0.262	0.262	0.262	0.258	0.321	0.321	0.321	0.321	0.321	0.321	0.283	0.283	0.247	0.258	0.247	0.256	0.256	0.248	0.317	0.317	0.313
33-3	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.232	0.210	0.210	0.210	0.247	0.231	0.231	0.231	0.231	0.228	0.325	0.325	0.325	0.325	0.325	0.325	0.287	0.287	0.251	0.255	0.243	0.256	0.256	0.248	0.282	0.282	0.279
33-4	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.236	0.214	0.214	0.214	0.243	0.228	0.228	0.228	0.228	0.224	0.320	0.320	0.320	0.320	0.320	0.320	0.287	0.287	0.235	0.239	0.228	0.248	0.248	0.240	0.283	0.283	0.279
33-5	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.239	0.229	0.229	0.229	0.206	0.258	0.258	0.258	0.258	0.254	0.321	0.321	0.321	0.321	0.321	0.321	0.279	0.279	0.243	0.255	0.243	0.256	0.256	0.248	0.312	0.312	0.308
33-6	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.236	0.214	0.214	0.214	0.247	0.231	0.231	0.231	0.231	0.228	0.316	0.316	0.316	0.316	0.316	0.316	0.283	0.283	0.243	0.247	0.235	0.251	0.251	0.244	0.279	0.279	0.275
33-7	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.232	0.210	0.210	0.210	0.247	0.228	0.228	0.228	0.228	0.224	0.316	0.316	0.316	0.316	0.316	0.316	0.279	0.279	0.239	0.243	0.231	0.247	0.247	0.240	0.279	0.279	0.275
33-8	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.232	0.210	0.210	0.210	0.247	0.228	0.228	0.228	0.228	0.224	0.316	0.316	0.316	0.316	0.316	0.316	0.279	0.279	0.239	0.243	0.231	0.247	0.247	0.240	0.279	0.279	0.275
33-9	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.232	0.210	0.210	0.210	0.247	0.228	0.228	0.228	0.228	0.224	0.316	0.316	0.316	0.316	0.316	0.316	0.279	0.279	0.239	0.243	0.231	0.247	0.247	0.240	0.279	0.279	0.275
33-10	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.232	0.210	0.210	0.210	0.247	0.228	0.228	0.228	0.228	0.224	0.316	0.316	0.316	0.316	0.316	0.316	0.279	0.279	0.239	0.243	0.231	0.247	0.247	0.240	0.279	0.279	0.275
33-11	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.232	0.210	0.210	0.210	0.247	0.228	0.228	0.228	0.228	0.224	0.316	0.316	0.316	0.316	0.316	0.316	0.279	0.279	0.239	0.243	0.231	0.247	0.247	0.240	0.279	0.279	0.275
33-12	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.232	0.210	0.210	0.210	0.247	0.228	0.228	0.228	0.228	0.224	0.316	0.316	0.316	0.316	0.316	0.316	0.279	0.279	0.239	0.243	0.231	0.247	0.247	0.240	0.279	0.279	0.275
33-13	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.232	0.210	0.210	0.210	0.247	0.228	0.228	0.228	0.228	0.224	0.316	0.316	0.316	0.316	0.316	0.316	0.279	0.279	0.239	0.243	0.231	0.247	0.247	0.240	0.279	0.279	0.275
33-14	0.256	0.256	0.256	0.256	0.256	0.256	0.256	0.244	0.229	0.229	0.229	0.244	0.231	0.231	0.231	0.231	0.228	0.329	0.329	0.329	0.329	0.329	0.329	0.287	0.287	0.235	0.239	0.235	0.255	0.255	0.247	0.286	0.286	0.282
33-15	0.256	0.256	0.256	0.256	0.256	0.256	0.256	0.244	0.229	0.229	0.229	0.244	0.231	0.231	0.231	0.231	0.228	0.329	0.329	0.329	0.329	0.329	0.329	0.287	0.287	0.235	0.239	0.235	0.255	0.255	0.247	0.286	0.286	0.282
33-16	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.239	0.225	0.225	0.225	0.206	0.258	0.258	0.258	0.258	0.254	0.317	0.317	0.317	0.317	0.317	0.317	0.279	0.279	0.243	0.255	0.243	0.260	0.260	0.252	0.312	0.312	0.308
33-17	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.236	0.221	0.221	0.221	0.202	0.254	0.254	0.254	0.254	0.250	0.312	0.312	0.312	0.312	0.312	0.312	0.275	0.275	0.243	0.255	0.243	0.256	0.256	0.248	0.308	0.308	0.304
33-18	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.243	0.221	0.221	0.221	0.210	0.254	0.254	0.254	0.254	0.250	0.321	0.321	0.321	0.321	0.321	0.321	0.283	0.283	0.247	0.251	0.247	0.264	0.264	0.256	0.308	0.308	0.304
33-19	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.236	0.229	0.229	0.229	0.206	0.258	0.258	0.258	0.258	0.254	0.326	0.326	0.326	0.326	0.326	0.326	0.287	0.287	0.251	0.262	0.251	0.268	0.268	0.260	0.321	0.321	0.317
33-20	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.239	0.232	0.232	0.232	0.202	0.258	0.258	0.258	0.258	0.254	0.317	0.317	0.317	0.317	0.317	0.317	0.287	0.287	0.243	0.255	0.243	0.252	0.252	0.244	0.312	0.312	0.308
33-21	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.247	0.217	0.217	0.217	0.224	0.258	0.258	0.258	0.258	0.254	0.321	0.321	0.321	0.321	0.321	0.321	0.271	0.271	0.270	0.274	0.270	0.264	0.264	0.255	0.316	0.316	0.312
33-22	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.240	0.225	0.225	0.225	0.232	0.258	0.258	0.258	0.258	0.254	0.330	0.330	0.330	0.330	0.330	0.330	0.279	0.279	0.278	0.282	0.278	0.272	0.272	0.264	0.325	0.325	0.320
33-23	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.247	0.217	0.217	0.217	0.224	0.258	0.258	0.258	0.258	0.254	0.321	0.321	0.321	0.321	0.321	0.321	0.271	0.271	0.270	0.274	0.270	0.264	0.264	0.255	0.316	0.316	0.312
33-24	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.247	0.217	0.217	0.217	0.224	0.258	0.258	0.258	0.258	0.254	0.321	0.321	0.321	0.321	0.321	0.321	0.271	0.271	0.270	0.274	0.270	0.264	0.264	0.255	0.316	0.316	0.312
33-25	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.244	0.221	0.221	0.221	0.235	0.266	0.266	0.266	0.266	0.262	0.334	0.334	0.334	0.334	0.334	0.334	0.288	0.288	0.286	0.291	0.278	0.280	0.280	0.272	0.334	0.334	0.329
34-1	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.203	0.246	0.246	0.246	0.232	0.225	0.225	0.225	0.225	0.229	0.289	0.284	0.284	0.284	0.284	0.284	0.266	0.266	0.254	0.254	0.262	0.215	0.215	0.219	0.245	0.245	0.242
35-1	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.232	0.206	0.206	0.206	0.232	0.221	0.221	0.221	0.221	0.224	0.278	0.278	0.278	0.278	0.278	0.278	0.271	0.271	0.248	0.248	0.248	0.248	0.248	0.236	0.243	0.243	0.239

Table 1. Continued.

	18-4	18-5	19-1	19-2	19-3	19-4	19-5	19-6	19-7	20-1	20-2	20-3	20-4	20-5	20-6	20-7	20-8	21-1	21-2	22-1	23-1	23-2	24-1	24-2	24-3	25-1	25-2	25-3	26-1	26-2	26-3	25-4	25-5	25-6
30-3	0.303	0.303	0.279	0.275	0.275	0.275	0.275	0.275	0.275	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.236	0.298	0.298	0.237	0.264	0.264	0.218	0.222	0.218	0.226	0.226	0.226	0.227	0.227	0.227	0.226	0.226	0.226
30-4	0.303	0.303	0.279	0.275	0.275	0.275	0.275	0.275	0.275	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.236	0.298	0.298	0.237	0.264	0.264	0.218	0.222	0.218	0.226	0.226	0.226	0.227	0.227	0.227	0.226	0.226	0.226
31-1	0.229	0.229	0.284	0.279	0.279	0.279	0.279	0.279	0.279	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.268	0.268	0.271	0.267	0.267	0.250	0.254	0.250	0.236	0.236	0.236	0.233	0.233	0.233	0.236	0.236	0.236
31-2	0.229	0.229	0.284	0.279	0.279	0.279	0.279	0.279	0.279	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.276	0.276	0.279	0.276	0.276	0.258	0.262	0.258	0.236	0.236	0.236	0.233	0.233	0.233	0.236	0.236	0.236
31-3	0.233	0.233	0.288	0.284	0.284	0.284	0.284	0.284	0.284	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.272	0.272	0.275	0.271	0.271	0.254	0.258	0.254	0.240	0.240	0.240	0.237	0.237	0.237	0.240	0.240	0.240
32-1	0.244	0.244	0.213	0.210	0.210	0.210	0.210	0.210	0.210	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.230	0.223	0.223	0.225	0.238	0.238	0.215	0.215	0.215	0.203	0.203	0.203	0.208	0.208	0.208	0.203	0.203	0.203
32-2	0.244	0.244	0.213	0.210	0.210	0.210	0.210	0.210	0.210	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.230	0.227	0.227	0.222	0.238	0.238	0.211	0.211	0.211	0.203	0.203	0.203	0.208	0.208	0.208	0.203	0.203	0.203
33-1	0.316	0.316	0.275	0.271	0.271	0.271	0.271	0.271	0.271	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.228	0.276	0.276	0.232	0.255	0.255	0.241	0.245	0.241	0.200	0.200	0.200	0.230	0.230	0.230	0.200	0.200	0.200
33-2	0.317	0.317	0.255	0.251	0.251	0.251	0.251	0.251	0.251	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.221	0.265	0.265	0.236	0.244	0.244	0.238	0.242	0.238	0.234	0.234	0.234	0.219	0.219	0.219	0.234	0.234	0.234
33-3	0.282	0.282	0.262	0.258	0.258	0.258	0.258	0.258	0.258	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.255	0.276	0.276	0.251	0.243	0.243	0.234	0.238	0.234	0.221	0.221	0.221	0.236	0.236	0.236	0.221	0.221	0.221
33-4	0.283	0.283	0.255	0.251	0.251	0.251	0.251	0.251	0.251	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.247	0.264	0.264	0.243	0.255	0.255	0.238	0.242	0.238	0.214	0.214	0.214	0.228	0.228	0.228	0.214	0.214	0.214
33-5	0.312	0.312	0.255	0.251	0.251	0.251	0.251	0.251	0.251	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.224	0.256	0.256	0.232	0.240	0.240	0.226	0.230	0.226	0.222	0.222	0.222	0.212	0.212	0.212	0.222	0.222	0.222
33-6	0.279	0.279	0.259	0.255	0.255	0.255	0.255	0.255	0.255	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.247	0.268	0.268	0.251	0.247	0.247	0.230	0.234	0.230	0.218	0.218	0.218	0.228	0.228	0.228	0.218	0.218	0.218
33-7	0.279	0.279	0.259	0.255	0.255	0.255	0.255	0.255	0.255	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.247	0.268	0.268	0.247	0.247	0.247	0.230	0.234	0.230	0.218	0.218	0.218	0.232	0.232	0.232	0.218	0.218	0.218
33-8	0.279	0.279	0.259	0.255	0.255	0.255	0.255	0.255	0.255	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.247	0.268	0.268	0.247	0.247	0.247	0.230	0.234	0.230	0.218	0.218	0.218	0.232	0.232	0.232	0.218	0.218	0.218
33-9	0.279	0.279	0.259	0.255	0.255	0.255	0.255	0.255	0.255	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.247	0.268	0.268	0.247	0.247	0.247	0.230	0.234	0.230	0.218	0.218	0.218	0.232	0.232	0.232	0.218	0.218	0.218
33-10	0.279	0.279	0.259	0.255	0.255	0.255	0.255	0.255	0.255	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.247	0.268	0.268	0.247	0.247	0.247	0.230	0.234	0.230	0.218	0.218	0.218	0.232	0.232	0.232	0.218	0.218	0.218
33-11	0.279	0.279	0.259	0.255	0.255	0.255	0.255	0.255	0.255	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.247	0.268	0.268	0.247	0.247	0.247	0.230	0.234	0.230	0.218	0.218	0.218	0.232	0.232	0.232	0.218	0.218	0.218
33-12	0.279	0.279	0.259	0.255	0.255	0.255	0.255	0.255	0.255	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.247	0.268	0.268	0.247	0.247	0.247	0.230	0.234	0.230	0.218	0.218	0.218	0.232	0.232	0.232	0.218	0.218	0.218
33-13	0.279	0.279	0.259	0.255	0.255	0.255	0.255	0.255	0.255	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.247	0.268	0.268	0.247	0.247	0.247	0.230	0.234	0.230	0.218	0.218	0.218	0.232	0.232	0.232	0.218	0.218	0.218
33-14	0.286	0.286	0.266	0.262	0.262	0.262	0.262	0.262	0.262	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.247	0.260	0.260	0.236	0.240	0.240	0.233	0.237	0.233	0.232	0.232	0.232	0.224	0.224	0.224	0.232	0.232	0.232
33-15	0.286	0.286	0.266	0.262	0.262	0.262	0.262	0.262	0.262	0.251	0.251	0.251	0.251	0.251	0.251	0.251	0.247	0.260	0.260	0.236	0.240	0.240	0.233	0.237	0.233	0.232	0.232	0.232	0.224	0.224	0.224	0.232	0.232	0.232
33-16	0.312	0.312	0.255	0.251	0.251	0.251	0.251	0.251	0.251	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.224	0.260	0.260	0.236	0.240	0.240	0.230	0.234	0.230	0.226	0.226	0.226	0.215	0.215	0.215	0.226	0.226	0.226
33-17	0.308	0.308	0.251	0.247	0.247	0.247	0.247	0.247	0.247	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.221	0.256	0.256	0.232	0.236	0.236	0.230	0.234	0.230	0.222	0.222	0.222	0.219	0.219	0.219	0.222	0.222	0.222
33-18	0.308	0.308	0.251	0.247	0.247	0.247	0.247	0.247	0.247	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.221	0.265	0.265	0.240	0.244	0.244	0.226	0.230	0.226	0.230	0.230	0.230	0.219	0.219	0.219	0.230	0.230	0.230
33-19	0.321	0.321	0.255	0.251	0.251	0.251	0.251	0.251	0.251	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.224	0.269	0.269	0.236	0.240	0.240	0.234	0.238	0.234	0.226	0.226	0.226	0.215	0.215	0.215	0.226	0.226	0.226
33-20	0.312	0.312	0.264	0.259	0.259	0.259	0.259	0.259	0.259	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.224	0.269	0.269	0.236	0.240	0.240	0.238	0.242	0.238	0.226	0.226	0.226	0.215	0.215	0.215	0.226	0.226	0.226
33-21	0.316	0.316	0.275	0.271	0.271	0.271	0.271	0.271	0.271	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.228	0.276	0.276	0.232	0.255	0.255	0.241	0.245	0.241	0.200	0.200	0.200	0.230	0.230	0.230	0.200	0.200	0.200
33-22	0.325	0.325	0.275	0.271	0.271	0.271	0.271	0.271	0.271	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.236	0.284	0.284	0.240	0.264	0.264	0.241	0.245	0.241	0.208	0.208	0.208	0.238	0.238	0.238	0.208	0.208	0.208
33-23	0.316	0.316	0.275	0.271	0.271	0.271	0.271	0.271	0.271	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.228	0.276	0.276	0.232	0.255	0.255	0.241	0.245	0.241	0.200	0.200	0.200	0.230	0.230	0.230	0.200	0.200	0.200
33-24	0.316	0.316	0.275	0.271	0.271	0.271	0.271	0.271	0.271	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.228	0.276	0.276	0.232	0.255	0.255	0.241	0.245	0.241	0.200	0.200	0.200	0.230	0.230	0.230	0.200	0.200	0.200
33-25	0.334	0.334	0.283	0.279	0.279	0.279	0.279	0.279	0.279	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.244	0.293	0.293	0.240	0.272	0.272	0.245	0.249	0.245	0.208	0.208	0.208	0.242	0.242	0.242	0.208	0.208	0.208
34-1	0.245	0.245	0.218	0.222	0.222	0.222	0.222	0.222	0.222	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.215	0.257	0.257	0.211	0.204	0.204	0.259	0.263	0.259	0.255	0.255	0.255	0.259	0.259	0.259	0.255	0.255	0.255
35-1	0.243	0.243	0.228	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.220	0.250	0.250	0.229	0.255	0.255	0.280	0.284	0.280	0.232	0.232	0.232	0.256	0.256	0.256	0.232	0.232	0.232

Table 1. Continued.

	27-1	27-2	27-3	27-4	27-5	27-6	28-1	28-2	28-3	28-4	28-5	28-6	28-7	28-8	28-9	28-10	28-11	28-12	28-13	28-14	28-15	28-16	28-17	28-18	28-19	28-20	28-21	28-22	28-23	29-1	29-2	29-3	30-1	30-2
30-3	0.222	0.215	0.222	0.207	0.207	0.219	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.168	0.164	0.161	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.207	0.203	0.207	0.000	0.000
30-4	0.222	0.215	0.222	0.207	0.207	0.219	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.168	0.164	0.161	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.207	0.203	0.207	0.000	0.000
31-1	0.251	0.255	0.251	0.255	0.255	0.255	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.256	0.252	0.256	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.208	0.208	0.208	0.232	0.232
31-2	0.251	0.255	0.251	0.247	0.247	0.255	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.265	0.260	0.265	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.208	0.208	0.208	0.232	0.232
31-3	0.255	0.259	0.255	0.251	0.251	0.259	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.260	0.256	0.260	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.212	0.212	0.212	0.228	0.228
32-1	0.169	0.176	0.169	0.176	0.176	0.173	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.235	0.231	0.235	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.221	0.218	0.221	0.200	0.200
32-2	0.169	0.176	0.169	0.176	0.176	0.173	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.235	0.231	0.235	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.225	0.221	0.225	0.204	0.204
33-1	0.214	0.211	0.214	0.211	0.211	0.207	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.184	0.180	0.184	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.204	0.200	0.204	0.170	0.170
33-2	0.211	0.207	0.211	0.207	0.207	0.200	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.178	0.174	0.178	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.212	0.208	0.212	0.167	0.167
33-3	0.200	0.203	0.200	0.203	0.203	0.203	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.191	0.188	0.191	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.224	0.220	0.224	0.181	0.181
33-4	0.207	0.211	0.207	0.211	0.211	0.211	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.198	0.194	0.198	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.235	0.231	0.235	0.184	0.184
33-5	0.203	0.200	0.203	0.200	0.200	0.193	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.185	0.181	0.185	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.212	0.208	0.212	0.163	0.163
33-6	0.207	0.211	0.207	0.211	0.211	0.211	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.195	0.191	0.195	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.239	0.235	0.239	0.188	0.188
33-7	0.207	0.211	0.207	0.211	0.211	0.211	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.195	0.191	0.195	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.239	0.235	0.239	0.185	0.185
33-8	0.207	0.211	0.207	0.211	0.211	0.211	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.195	0.191	0.195	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.239	0.235	0.239	0.185	0.185
33-9	0.207	0.211	0.207	0.211	0.211	0.211	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.195	0.191	0.195	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.239	0.235	0.239	0.185	0.185
33-10	0.207	0.211	0.207	0.211	0.211	0.211	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.195	0.191	0.195	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.239	0.235	0.239	0.185	0.185
33-11	0.207	0.211	0.207	0.211	0.211	0.211	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.195	0.191	0.195	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.239	0.235	0.239	0.185	0.185
33-12	0.207	0.211	0.207	0.211	0.211	0.211	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.195	0.191	0.195	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.239	0.235	0.239	0.185	0.185
33-13	0.207	0.211	0.207	0.211	0.211	0.211	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.195	0.191	0.195	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.239	0.235	0.239	0.185	0.185
33-14	0.215	0.219	0.215	0.219	0.219	0.219	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.187	0.184	0.187	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.244	0.240	0.244	0.181	0.181
33-15	0.215	0.219	0.215	0.219	0.219	0.219	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.187	0.184	0.187	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.244	0.240	0.244	0.181	0.181
33-16	0.207	0.204	0.207	0.204	0.204	0.196	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.185	0.181	0.185	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.212	0.208	0.212	0.167	0.167
33-17	0.207	0.204	0.207	0.204	0.204	0.196	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.181	0.178	0.181	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.212	0.208	0.212	0.167	0.167
33-18	0.211	0.207	0.211	0.207	0.207	0.200	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.181	0.178	0.181	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.216	0.212	0.216	0.171	0.171
33-19	0.215	0.211	0.215	0.211	0.211	0.204	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.178	0.174	0.178	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.212	0.208	0.212	0.160	0.160
33-20	0.215	0.211	0.215	0.211	0.211	0.204	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.181	0.178	0.181	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.220	0.216	0.220	0.171	0.171
33-21	0.214	0.211	0.214	0.211	0.211	0.207	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.184	0.180	0.184	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.204	0.200	0.204	0.170	0.170
33-22	0.214	0.211	0.214	0.211	0.211	0.207	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.177	0.173	0.177	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.211	0.207	0.211	0.178	0.178
33-23	0.214	0.211	0.214	0.211	0.211	0.207	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.184	0.180	0.184	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.204	0.200	0.204	0.170	0.170
33-24	0.214	0.211	0.214	0.211	0.211	0.207	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.184	0.180	0.184	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.204	0.200	0.204	0.170	0.170
33-25	0.214	0.211	0.214	0.211	0.211	0.207	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.180	0.177	0.180	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.211	0.207	0.211	0.181	0.181
34-1	0.262	0.249	0.262	0.257	0.257	0.262	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.226	0.222	0.226	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.242	0.242	0.242	0.251	0.251
35-1	0.251	0.240	0.251	0.247	0.247	0.244	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.299	0.294	0.299	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.239	0.239	0.239	0.243	0.243

Table 1. Continued.

	30-3	30-4	31-1	31-2	31-3	32-1	32-2	33-1	33-2	33-3	33-4	33-5	33-6	33-7	33-8	33-9	33-10	33-11	33-12	33-13	33-14	33-15	33-16	33-17	33-18	33-19	33-20	33-21	33-22	33-23	33-24	33-25	34-1	35-1
30-3																																		
30-4	0.000																																	
31-1	0.232	0.232																																
31-2	0.232	0.232	0.005																															
31-3	0.228	0.228	0.003	0.003																														
32-1	0.200	0.200	0.222	0.222	0.225																													
32-2	0.204	0.204	0.222	0.222	0.225	0.005																												
33-1	0.170	0.170	0.192	0.200	0.196	0.219	0.222																											
33-2	0.167	0.167	0.204	0.211	0.207	0.208	0.212	0.054																										
33-3	0.181	0.181	0.185	0.193	0.189	0.186	0.182	0.088	0.088																									
33-4	0.184	0.184	0.185	0.193	0.189	0.197	0.197	0.087	0.082	0.022																								
33-5	0.163	0.163	0.200	0.207	0.204	0.200	0.204	0.051	0.008	0.085	0.078																							
33-6	0.188	0.188	0.185	0.193	0.189	0.201	0.201	0.088	0.082	0.017	0.011	0.079																						
33-7	0.185	0.185	0.185	0.193	0.189	0.197	0.197	0.088	0.082	0.014	0.008	0.079	0.003																					
33-8	0.185	0.185	0.185	0.193	0.189	0.197	0.197	0.088	0.082	0.014	0.008	0.079	0.003	0.000																				
33-9	0.185	0.185	0.185	0.193	0.189	0.197	0.197	0.088	0.082	0.014	0.008	0.079	0.003	0.000	0.000																			
33-10	0.185	0.185	0.185	0.193	0.189	0.197	0.197	0.088	0.082	0.014	0.008	0.079	0.003	0.000	0.000	0.000																		
33-11	0.185	0.185	0.185	0.193	0.189	0.197	0.197	0.088	0.082	0.014	0.008	0.079	0.003	0.000	0.000	0.000	0.000																	
33-12	0.185	0.185	0.185	0.193	0.189	0.197	0.197	0.088	0.082	0.014	0.008	0.079	0.003	0.000	0.000	0.000	0.000	0.000																
33-13	0.185	0.185	0.185	0.193	0.189	0.197	0.197	0.088	0.082	0.014	0.008	0.079	0.003	0.000	0.000	0.000	0.000	0.000	0.000															
33-14	0.181	0.181	0.196	0.204	0.200	0.186	0.183	0.091	0.066	0.045	0.045	0.063	0.045	0.042	0.042	0.042	0.042	0.042	0.042	0.042														
33-15	0.181	0.181	0.196	0.204	0.200	0.186	0.183	0.091	0.066	0.045	0.045	0.063	0.045	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.000													
33-16	0.167	0.167	0.204	0.211	0.207	0.204	0.208	0.048	0.005	0.082	0.075	0.003	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.060	0.060												
33-17	0.167	0.167	0.200	0.207	0.204	0.200	0.204	0.045	0.008	0.079	0.072	0.005	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.063	0.063	0.003											
33-18	0.171	0.171	0.200	0.207	0.204	0.208	0.212	0.051	0.008	0.079	0.072	0.005	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.057	0.057	0.003	0.005										
33-19	0.160	0.160	0.200	0.207	0.204	0.208	0.212	0.048	0.011	0.082	0.075	0.008	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.060	0.060	0.005	0.008	0.008									
33-20	0.171	0.171	0.204	0.211	0.207	0.204	0.208	0.054	0.005	0.082	0.075	0.008	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.060	0.060	0.005	0.008	0.008	0.011								
33-21	0.170	0.170	0.192	0.200	0.196	0.219	0.222	0.000	0.054	0.088	0.087	0.051	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.091	0.091	0.048	0.045	0.051	0.048	0.054							
33-22	0.178	0.178	0.192	0.200	0.196	0.226	0.230	0.005	0.054	0.088	0.087	0.051	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.091	0.091	0.048	0.045	0.051	0.048	0.054	0.005						
33-23	0.170	0.170	0.192	0.200	0.196	0.219	0.222	0.000	0.054	0.088	0.087	0.051	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.091	0.091	0.048	0.045	0.051	0.048	0.054	0.000	0.005					
33-24	0.170	0.170	0.192	0.200	0.196	0.219	0.222	0.000	0.054	0.088	0.087	0.051	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.091	0.091	0.048	0.045	0.051	0.048	0.054	0.000	0.005	0.000				
33-25	0.181	0.181	0.192	0.200	0.196	0.234	0.238	0.011	0.054	0.088	0.087	0.051	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.097	0.097	0.048	0.045	0.051	0.048	0.054	0.011	0.005	0.011	0.011			
34-1	0.251	0.251	0.265	0.265	0.269	0.209	0.209	0.234	0.211	0.231	0.226	0.215	0.222	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.219	0.219	0.211	0.207	0.215	0.215	0.219	0.234	0.226	0.234	0.234	0.226		
35-1	0.243	0.243	0.280	0.280	0.284	0.233	0.237	0.214	0.222	0.245	0.244	0.225	0.244	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.244	0.244	0.222	0.222	0.218	0.225	0.225	0.214	0.214	0.214	0.214	0.222	0.186	

Table 1. Continued.

	1-1	1-2	1-3	2-1	3-1	4-1	4-2	4-3	5-1	5-2	6-1	6-2	6-3	6-4	6-5	6-6	6-7	6-8	6-9	6-10	6-11	6-12	6-13	6-14	6-15	6-16	6-17	6-18	6-19	6-20	6-21	6-22	6-23	6-24
34-2	0.297	0.297	0.297	0.256	0.253	0.285	0.277	0.277	0.226	0.238	0.217	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.224	0.224	0.224	0.221	0.224	0.224	0.213	0.213	0.213	0.213	0.213	0.228	0.224	0.228	0.221	0.228
35-2	0.307	0.307	0.307	0.262	0.277	0.241	0.237	0.237	0.240	0.228	0.231	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.250	0.247	0.247	0.247	0.250	0.247	0.239	0.239	0.239	0.239	0.239	0.247	0.247	0.247	0.247	0.247
35-3	0.307	0.307	0.307	0.261	0.278	0.241	0.237	0.237	0.240	0.228	0.232	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.251	0.247	0.247	0.247	0.251	0.247	0.239	0.239	0.239	0.239	0.239	0.247	0.247	0.247	0.247	0.247
34-3	0.289	0.289	0.289	0.248	0.245	0.277	0.277	0.277	0.214	0.226	0.221	0.224	0.217	0.224	0.224	0.217	0.224	0.224	0.221	0.221	0.221	0.217	0.221	0.221	0.217	0.217	0.217	0.217	0.217	0.224	0.221	0.224	0.217	0.224
34-4	0.289	0.289	0.289	0.260	0.241	0.277	0.277	0.277	0.218	0.222	0.229	0.232	0.224	0.232	0.232	0.224	0.232	0.232	0.228	0.228	0.228	0.224	0.228	0.228	0.225	0.225	0.225	0.225	0.225	0.232	0.228	0.232	0.224	0.232
36-1	0.284	0.284	0.284	0.221	0.287	0.272	0.272	0.272	0.242	0.250	0.222	0.218	0.222	0.218	0.218	0.222	0.218	0.218	0.226	0.218	0.218	0.222	0.226	0.218	0.229	0.229	0.229	0.229	0.229	0.214	0.218	0.214	0.222	0.214
36-2	0.289	0.289	0.289	0.221	0.282	0.276	0.276	0.276	0.237	0.245	0.225	0.215	0.226	0.215	0.215	0.226	0.215	0.215	0.230	0.222	0.222	0.226	0.230	0.222	0.226	0.226	0.226	0.226	0.226	0.218	0.222	0.218	0.226	0.218
34-5	0.289	0.289	0.289	0.248	0.249	0.272	0.272	0.272	0.203	0.214	0.225	0.228	0.221	0.228	0.228	0.221	0.228	0.228	0.224	0.224	0.224	0.221	0.224	0.224	0.221	0.221	0.221	0.221	0.221	0.228	0.224	0.228	0.221	0.228
34-6	0.289	0.289	0.289	0.248	0.245	0.272	0.272	0.272	0.218	0.230	0.221	0.224	0.217	0.224	0.224	0.217	0.224	0.224	0.221	0.221	0.221	0.217	0.221	0.221	0.217	0.217	0.217	0.217	0.217	0.224	0.221	0.224	0.217	0.224
34-7	0.289	0.289	0.289	0.248	0.249	0.272	0.272	0.272	0.203	0.214	0.225	0.228	0.221	0.228	0.228	0.221	0.228	0.228	0.224	0.224	0.224	0.221	0.224	0.224	0.221	0.221	0.221	0.221	0.221	0.228	0.224	0.228	0.221	0.228
34-8	0.289	0.289	0.289	0.248	0.245	0.272	0.272	0.272	0.218	0.230	0.221	0.224	0.217	0.224	0.224	0.217	0.224	0.224	0.221	0.221	0.221	0.217	0.221	0.221	0.217	0.217	0.217	0.217	0.217	0.224	0.221	0.224	0.217	0.224
34-9	0.280	0.280	0.280	0.256	0.237	0.272	0.272	0.272	0.222	0.226	0.217	0.221	0.213	0.221	0.221	0.213	0.221	0.221	0.217	0.217	0.217	0.213	0.217	0.217	0.213	0.213	0.213	0.213	0.213	0.221	0.217	0.221	0.213	0.221
34-10	0.297	0.297	0.297	0.256	0.253	0.285	0.277	0.277	0.226	0.238	0.217	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.224	0.224	0.224	0.221	0.224	0.224	0.213	0.213	0.213	0.213	0.213	0.228	0.224	0.228	0.221	0.228
34-11	0.293	0.293	0.293	0.256	0.253	0.277	0.277	0.277	0.222	0.234	0.225	0.228	0.221	0.228	0.228	0.221	0.228	0.228	0.224	0.217	0.217	0.221	0.224	0.224	0.221	0.221	0.221	0.221	0.221	0.221	0.217	0.221	0.221	0.221
34-12	0.293	0.293	0.293	0.244	0.241	0.268	0.268	0.268	0.214	0.226	0.225	0.228	0.221	0.228	0.228	0.221	0.228	0.228	0.224	0.224	0.224	0.221	0.217	0.224	0.221	0.221	0.221	0.221	0.221	0.228	0.224	0.228	0.221	0.228
37-1	0.230	0.230	0.230	0.256	0.272	0.262	0.255	0.255	0.252	0.248	0.251	0.255	0.255	0.255	0.255	0.255	0.255	0.255	0.259	0.259	0.259	0.255	0.251	0.251	0.255	0.255	0.255	0.255	0.255	0.255	0.259	0.255	0.255	0.255
37-2	0.290	0.290	0.290	0.300	0.242	0.233	0.237	0.237	0.221	0.232	0.232	0.236	0.240	0.236	0.236	0.240	0.236	0.236	0.244	0.240	0.240	0.240	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.240	0.236	0.240	0.236
38-1	0.257	0.257	0.257	0.244	0.241	0.236	0.236	0.236	0.250	0.238	0.214	0.207	0.218	0.207	0.207	0.218	0.207	0.207	0.222	0.222	0.222	0.218	0.214	0.214	0.207	0.207	0.207	0.207	0.207	0.218	0.222	0.218	0.218	0.218
39-1	0.242	0.242	0.242	0.242	0.211	0.261	0.257	0.257	0.232	0.236	0.214	0.203	0.207	0.203	0.203	0.207	0.203	0.203	0.210	0.207	0.207	0.207	0.210	0.203	0.199	0.199	0.199	0.199	0.199	0.203	0.207	0.203	0.207	0.203
40-1	0.257	0.257	0.257	0.252	0.251	0.244	0.240	0.240	0.267	0.250	0.214	0.207	0.214	0.207	0.207	0.214	0.207	0.207	0.218	0.214	0.214	0.214	0.218	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.214	0.210	0.214	0.210
40-2	0.257	0.257	0.257	0.252	0.251	0.244	0.240	0.240	0.267	0.250	0.214	0.207	0.214	0.207	0.207	0.214	0.207	0.207	0.218	0.214	0.214	0.214	0.218	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.214	0.210	0.214	0.210
40-3	0.253	0.253	0.253	0.256	0.255	0.240	0.236	0.236	0.267	0.250	0.214	0.207	0.214	0.207	0.207	0.214	0.207	0.207	0.218	0.214	0.214	0.214	0.218	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.214	0.210	0.214	0.210
40-4	0.257	0.257	0.257	0.252	0.251	0.244	0.240	0.240	0.267	0.250	0.214	0.207	0.214	0.207	0.207	0.214	0.207	0.207	0.218	0.214	0.214	0.214	0.218	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.214	0.210	0.214	0.210
40-5	0.253	0.253	0.253	0.256	0.255	0.240	0.236	0.236	0.267	0.250	0.214	0.207	0.214	0.207	0.207	0.214	0.207	0.207	0.218	0.214	0.214	0.214	0.218	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.214	0.210	0.214	0.210
40-6	0.253	0.253	0.253	0.256	0.255	0.240	0.236	0.236	0.267	0.250	0.214	0.207	0.214	0.207	0.207	0.214	0.207	0.207	0.218	0.214	0.214	0.214	0.218	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.214	0.210	0.214	0.210
40-7	0.253	0.253	0.253	0.256	0.255	0.240	0.236	0.236	0.267	0.250	0.214	0.207	0.214	0.207	0.207	0.214	0.207	0.207	0.218	0.214	0.214	0.214	0.218	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.214	0.210	0.214	0.210
40-8	0.253	0.253	0.253	0.256	0.255	0.240	0.236	0.236	0.267	0.250	0.214	0.207	0.214	0.207	0.207	0.214	0.207	0.207	0.218	0.214	0.214	0.214	0.218	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.214	0.210	0.214	0.210
41-1	0.253	0.253	0.253	0.253	0.246	0.242	0.242	0.242	0.204	0.216	0.189	0.200	0.192	0.200	0.200	0.192	0.200	0.200	0.196	0.196	0.196	0.192	0.196	0.196	0.192	0.192	0.192	0.192	0.192	0.200	0.196	0.200	0.192	0.200
42-1	0.257	0.257	0.257	0.252	0.251	0.244	0.240	0.240	0.267	0.250	0.214	0.207	0.214	0.207	0.207	0.214	0.207	0.207	0.218	0.214	0.214	0.214	0.218	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.214	0.210	0.214	0.210
42-2	0.257	0.257	0.257	0.252	0.251	0.244	0.240	0.240	0.267	0.250	0.214	0.207	0.214	0.207	0.207	0.214	0.207	0.207	0.218	0.214	0.214	0.214	0.218	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.214	0.210	0.214	0.210

Table 1. Continued.

	6-25	6-26	6-27	6-28	6-29	6-30	6-31	6-32	6-33	6-34	6-35	6-36	6-37	7-1	7-2	7-3	7-4	7-5	7-6	7-7	7-8	8-1	8-2	8-3	8-4	8-5	8-6	8-7	8-8	8-9	8-10	8-11	9-1	9-2
34-2	0.228	0.228	0.224	0.221	0.224	0.221	0.221	0.221	0.228	0.228	0.232	0.221	0.225	0.232	0.243	0.235	0.235	0.228	0.239	0.232	0.239	0.285	0.289	0.285	0.285	0.281	0.285	0.285	0.285	0.289	0.285	0.289	0.221	0.221
35-2	0.247	0.247	0.247	0.247	0.250	0.247	0.247	0.247	0.247	0.250	0.247	0.231	0.231	0.267	0.276	0.271	0.279	0.263	0.283	0.267	0.283	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.275	0.275	0.271	0.275	0.235	0.235
35-3	0.247	0.247	0.247	0.247	0.251	0.247	0.247	0.247	0.247	0.251	0.247	0.232	0.232	0.267	0.276	0.271	0.280	0.263	0.284	0.267	0.284	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.276	0.276	0.271	0.276	0.239	0.239
34-3	0.224	0.224	0.221	0.224	0.228	0.224	0.224	0.224	0.224	0.224	0.228	0.225	0.229	0.235	0.239	0.239	0.239	0.224	0.243	0.235	0.243	0.272	0.277	0.272	0.272	0.268	0.272	0.272	0.272	0.277	0.272	0.277	0.217	0.217
34-4	0.232	0.232	0.228	0.232	0.236	0.232	0.232	0.232	0.232	0.232	0.236	0.232	0.236	0.239	0.235	0.243	0.235	0.228	0.239	0.239	0.239	0.272	0.277	0.272	0.272	0.268	0.280	0.280	0.272	0.277	0.272	0.277	0.228	0.228
36-1	0.214	0.214	0.226	0.218	0.222	0.218	0.218	0.218	0.214	0.222	0.214	0.218	0.222	0.237	0.233	0.249	0.237	0.237	0.234	0.245	0.234	0.286	0.277	0.286	0.286	0.282	0.282	0.282	0.290	0.286	0.286	0.286	0.215	0.215
36-2	0.218	0.218	0.230	0.215	0.218	0.215	0.215	0.215	0.218	0.226	0.218	0.222	0.225	0.237	0.233	0.249	0.237	0.237	0.233	0.245	0.233	0.287	0.278	0.287	0.287	0.282	0.283	0.283	0.291	0.287	0.287	0.287	0.212	0.212
34-5	0.228	0.228	0.224	0.228	0.232	0.228	0.228	0.228	0.228	0.228	0.232	0.229	0.232	0.239	0.243	0.243	0.243	0.228	0.247	0.239	0.247	0.268	0.272	0.268	0.268	0.264	0.268	0.268	0.268	0.272	0.268	0.272	0.224	0.224
34-6	0.224	0.224	0.221	0.224	0.228	0.224	0.224	0.224	0.224	0.224	0.228	0.225	0.229	0.235	0.239	0.239	0.239	0.224	0.243	0.235	0.243	0.272	0.277	0.272	0.272	0.268	0.272	0.272	0.272	0.277	0.272	0.277	0.217	0.217
34-7	0.228	0.228	0.224	0.228	0.232	0.228	0.228	0.228	0.228	0.228	0.232	0.229	0.232	0.239	0.243	0.243	0.243	0.228	0.247	0.239	0.247	0.268	0.272	0.268	0.268	0.264	0.268	0.268	0.268	0.272	0.268	0.272	0.224	0.224
34-8	0.224	0.224	0.221	0.224	0.228	0.224	0.224	0.224	0.224	0.224	0.228	0.225	0.229	0.235	0.239	0.239	0.239	0.224	0.243	0.235	0.243	0.272	0.277	0.272	0.272	0.268	0.272	0.272	0.272	0.277	0.272	0.277	0.217	0.217
34-9	0.221	0.221	0.217	0.221	0.224	0.221	0.221	0.221	0.221	0.221	0.224	0.221	0.225	0.232	0.235	0.235	0.235	0.220	0.239	0.232	0.239	0.264	0.268	0.264	0.264	0.260	0.272	0.272	0.264	0.268	0.264	0.268	0.213	0.213
34-10	0.228	0.228	0.224	0.221	0.224	0.221	0.221	0.221	0.228	0.228	0.232	0.221	0.225	0.232	0.243	0.235	0.235	0.228	0.239	0.232	0.239	0.285	0.289	0.285	0.285	0.281	0.285	0.285	0.285	0.289	0.285	0.289	0.221	0.221
34-11	0.221	0.221	0.224	0.228	0.232	0.228	0.228	0.228	0.221	0.228	0.224	0.221	0.225	0.239	0.239	0.243	0.243	0.228	0.247	0.239	0.247	0.277	0.281	0.277	0.277	0.272	0.276	0.276	0.277	0.281	0.277	0.281	0.221	0.221
34-12	0.228	0.228	0.224	0.228	0.232	0.228	0.228	0.228	0.228	0.228	0.232	0.229	0.232	0.232	0.235	0.235	0.235	0.220	0.239	0.232	0.239	0.277	0.281	0.277	0.277	0.272	0.276	0.276	0.277	0.281	0.277	0.281	0.221	0.221
37-1	0.255	0.255	0.259	0.255	0.259	0.255	0.255	0.255	0.255	0.247	0.255	0.255	0.259	0.268	0.280	0.272	0.272	0.264	0.276	0.268	0.276	0.244	0.247	0.244	0.244	0.240	0.243	0.243	0.251	0.247	0.244	0.247	0.231	0.231
37-2	0.236	0.236	0.240	0.236	0.240	0.236	0.236	0.236	0.236	0.240	0.236	0.232	0.232	0.251	0.260	0.251	0.268	0.251	0.268	0.255	0.268	0.286	0.282	0.286	0.286	0.282	0.286	0.286	0.290	0.286	0.286	0.286	0.223	0.223
38-1	0.218	0.218	0.218	0.207	0.210	0.207	0.207	0.207	0.218	0.210	0.222	0.218	0.218	0.280	0.271	0.272	0.272	0.264	0.272	0.276	0.272	0.260	0.264	0.260	0.260	0.256	0.268	0.268	0.264	0.260	0.260	0.256	0.249	0.249
39-1	0.203	0.203	0.210	0.203	0.207	0.203	0.203	0.203	0.203	0.207	0.207	0.214	0.217	0.243	0.240	0.247	0.243	0.236	0.247	0.243	0.247	0.271	0.271	0.271	0.271	0.271	0.279	0.279	0.280	0.276	0.271	0.276	0.218	0.218
40-1	0.210	0.210	0.218	0.207	0.210	0.207	0.207	0.207	0.210	0.214	0.214	0.214	0.218	0.236	0.236	0.232	0.232	0.240	0.236	0.236	0.236	0.253	0.257	0.253	0.253	0.249	0.265	0.265	0.261	0.257	0.253	0.257	0.196	0.196
40-2	0.210	0.210	0.218	0.207	0.210	0.207	0.207	0.207	0.210	0.214	0.214	0.214	0.218	0.236	0.236	0.232	0.232	0.240	0.236	0.236	0.236	0.253	0.257	0.253	0.253	0.249	0.265	0.265	0.261	0.257	0.253	0.257	0.196	0.196
40-3	0.210	0.210	0.218	0.207	0.210	0.207	0.207	0.207	0.210	0.214	0.214	0.214	0.218	0.240	0.240	0.236	0.236	0.244	0.240	0.240	0.240	0.253	0.257	0.253	0.253	0.249	0.265	0.265	0.261	0.257	0.253	0.257	0.199	0.199
40-4	0.210	0.210	0.218	0.207	0.210	0.207	0.207	0.207	0.210	0.214	0.214	0.214	0.218	0.236	0.236	0.232	0.232	0.240	0.236	0.236	0.236	0.253	0.257	0.253	0.253	0.249	0.265	0.265	0.261	0.257	0.253	0.257	0.196	0.196
40-5	0.210	0.210	0.218	0.207	0.210	0.207	0.207	0.207	0.210	0.214	0.214	0.214	0.218	0.240	0.240	0.236	0.236	0.244	0.240	0.240	0.240	0.253	0.257	0.253	0.253	0.249	0.265	0.265	0.261	0.257	0.253	0.257	0.199	0.199
40-6	0.210	0.210	0.218	0.207	0.210	0.207	0.207	0.207	0.210	0.214	0.214	0.214	0.218	0.240	0.240	0.236	0.236	0.244	0.240	0.240	0.240	0.253	0.257	0.253	0.253	0.249	0.265	0.265	0.261	0.257	0.253	0.257	0.199	0.199
40-7	0.210	0.210	0.218	0.207	0.210	0.207	0.207	0.207	0.210	0.214	0.214	0.214	0.218	0.240	0.240	0.236	0.236	0.244	0.240	0.240	0.240	0.253	0.257	0.253	0.253	0.249	0.265	0.265	0.261	0.257	0.253	0.257	0.199	0.199
40-8	0.210	0.210	0.218	0.207	0.210	0.207	0.207	0.207	0.210	0.214	0.214	0.214	0.218	0.240	0.240	0.236	0.236	0.244	0.240	0.240	0.240	0.253	0.257	0.253	0.253	0.249	0.265	0.265	0.261	0.257	0.253	0.257	0.199	0.199
41-1	0.200	0.200	0.192	0.200	0.203	0.200	0.200	0.200	0.200	0.200	0.203	0.192	0.192	0.204	0.200	0.200	0.200	0.189	0.207	0.196	0.207	0.241	0.245	0.241	0.241	0.237	0.245	0.245	0.241	0.245	0.241	0.245	0.199	0.199
42-1	0.210	0.210	0.218	0.207	0.210	0.207	0.207	0.207	0.210	0.214	0.214	0.214	0.218	0.236	0.236	0.232	0.232	0.240	0.236	0.236	0.236	0.253	0.257	0.253	0.253	0.249	0.265	0.265	0.261	0.257	0.253	0.257	0.196	0.196
42-2	0.210	0.210	0.218	0.207	0.210	0.207	0.207	0.207	0.210	0.214	0.214	0.214	0.218	0.236	0.236	0.232	0.232	0.240	0.236	0.236	0.236	0.253	0.257	0.253	0.253	0.249	0.265	0.265	0.261	0.257	0.253	0.257	0.196	0.196

Table 1. Continued.

	9-3	9-4	9-5	9-6	9-7	9-8	9-9	10-1	11-1	11-2	11-3	12-1	13-1	13-2	13-3	13-4	13-5	14-1	14-2	14-3	14-4	14-5	14-6	15-1	15-2	16-1	16-2	16-3	17-1	17-2	17-3	18-1	18-2	18-3
34-2	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.210	0.238	0.238	0.238	0.225	0.233	0.233	0.233	0.233	0.237	0.289	0.284	0.284	0.284	0.284	0.284	0.262	0.262	0.250	0.258	0.250	0.211	0.211	0.215	0.241	0.241	0.238
35-2	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.232	0.206	0.206	0.206	0.232	0.221	0.221	0.221	0.221	0.224	0.278	0.278	0.278	0.278	0.278	0.278	0.271	0.271	0.248	0.248	0.248	0.248	0.248	0.236	0.243	0.243	0.239
35-3	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.232	0.206	0.206	0.206	0.236	0.221	0.221	0.221	0.221	0.224	0.279	0.279	0.279	0.279	0.279	0.279	0.271	0.271	0.248	0.248	0.248	0.245	0.245	0.233	0.243	0.243	0.239
34-3	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.203	0.238	0.238	0.238	0.221	0.225	0.225	0.225	0.225	0.229	0.280	0.276	0.276	0.276	0.276	0.276	0.253	0.253	0.242	0.250	0.250	0.207	0.207	0.211	0.233	0.233	0.230
34-4	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.207	0.242	0.242	0.242	0.225	0.233	0.233	0.233	0.233	0.237	0.280	0.276	0.276	0.276	0.276	0.276	0.241	0.241	0.246	0.254	0.254	0.211	0.211	0.222	0.237	0.237	0.234
36-1	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.204	0.231	0.231	0.231	0.224	0.267	0.267	0.267	0.267	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.247	0.247	0.259	0.263	0.267	0.222	0.222	0.226	0.249	0.249	0.245
36-2	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.205	0.231	0.231	0.231	0.220	0.263	0.263	0.263	0.263	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.251	0.251	0.255	0.259	0.263	0.218	0.218	0.222	0.252	0.252	0.249
34-5	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.192	0.234	0.234	0.234	0.229	0.229	0.229	0.229	0.229	0.233	0.276	0.272	0.272	0.272	0.272	0.272	0.249	0.249	0.238	0.246	0.246	0.211	0.211	0.215	0.241	0.241	0.238
34-6	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.207	0.242	0.242	0.242	0.225	0.229	0.229	0.229	0.229	0.233	0.284	0.280	0.280	0.280	0.280	0.280	0.249	0.249	0.238	0.246	0.246	0.207	0.207	0.211	0.233	0.233	0.230
34-7	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.192	0.234	0.234	0.234	0.229	0.229	0.229	0.229	0.229	0.233	0.276	0.272	0.272	0.272	0.272	0.272	0.249	0.249	0.238	0.246	0.246	0.211	0.211	0.215	0.241	0.241	0.238
34-8	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.207	0.242	0.242	0.242	0.225	0.229	0.229	0.229	0.229	0.233	0.284	0.280	0.280	0.280	0.280	0.280	0.249	0.249	0.238	0.246	0.246	0.207	0.207	0.211	0.233	0.233	0.230
34-9	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.207	0.238	0.238	0.238	0.217	0.225	0.225	0.225	0.225	0.229	0.280	0.276	0.276	0.276	0.276	0.276	0.249	0.249	0.246	0.254	0.254	0.200	0.200	0.203	0.229	0.229	0.226
34-10	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.210	0.238	0.238	0.238	0.225	0.233	0.233	0.233	0.233	0.237	0.289	0.284	0.284	0.284	0.284	0.284	0.262	0.262	0.250	0.258	0.250	0.211	0.211	0.215	0.241	0.241	0.238
34-11	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.207	0.238	0.238	0.238	0.229	0.229	0.229	0.229	0.229	0.233	0.280	0.276	0.276	0.276	0.276	0.276	0.257	0.257	0.250	0.250	0.258	0.207	0.207	0.211	0.237	0.237	0.234
34-12	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.210	0.246	0.246	0.246	0.229	0.233	0.233	0.233	0.233	0.237	0.289	0.284	0.284	0.284	0.284	0.284	0.245	0.245	0.234	0.242	0.242	0.211	0.211	0.215	0.237	0.237	0.234
37-1	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.249	0.261	0.261	0.261	0.290	0.249	0.249	0.249	0.249	0.253	0.294	0.289	0.289	0.289	0.289	0.289	0.272	0.272	0.259	0.280	0.251	0.241	0.241	0.237	0.235	0.235	0.234
37-2	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.242	0.219	0.219	0.219	0.257	0.211	0.211	0.211	0.211	0.215	0.264	0.264	0.264	0.264	0.264	0.264	0.250	0.250	0.234	0.246	0.234	0.230	0.230	0.234	0.239	0.239	0.239
38-1	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.230	0.246	0.246	0.246	0.250	0.265	0.265	0.265	0.265	0.269	0.286	0.286	0.286	0.286	0.286	0.286	0.276	0.276	0.249	0.265	0.249	0.238	0.238	0.242	0.216	0.216	0.216
39-1	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.241	0.192	0.192	0.192	0.196	0.224	0.224	0.224	0.224	0.228	0.258	0.254	0.254	0.254	0.254	0.254	0.276	0.276	0.251	0.259	0.251	0.215	0.215	0.211	0.222	0.222	0.225
40-1	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.207	0.204	0.204	0.204	0.225	0.250	0.250	0.250	0.250	0.254	0.292	0.288	0.288	0.288	0.288	0.288	0.280	0.280	0.248	0.252	0.248	0.231	0.231	0.227	0.258	0.258	0.257
40-2	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.207	0.204	0.204	0.204	0.225	0.250	0.250	0.250	0.250	0.254	0.292	0.288	0.288	0.288	0.288	0.288	0.280	0.280	0.248	0.252	0.248	0.231	0.231	0.227	0.258	0.258	0.257
40-3	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.211	0.200	0.200	0.200	0.222	0.250	0.250	0.250	0.250	0.254	0.292	0.288	0.288	0.288	0.288	0.288	0.276	0.276	0.248	0.252	0.248	0.235	0.235	0.231	0.258	0.258	0.257
40-4	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.207	0.204	0.204	0.204	0.225	0.250	0.250	0.250	0.250	0.254	0.292	0.288	0.288	0.288	0.288	0.288	0.280	0.280	0.248	0.252	0.248	0.231	0.231	0.227	0.258	0.258	0.257
40-5	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.211	0.200	0.200	0.200	0.222	0.250	0.250	0.250	0.250	0.254	0.292	0.288	0.288	0.288	0.288	0.288	0.276	0.276	0.248	0.252	0.248	0.235	0.235	0.231	0.258	0.258	0.257
40-6	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.211	0.200	0.200	0.200	0.222	0.250	0.250	0.250	0.250	0.254	0.292	0.288	0.288	0.288	0.288	0.288	0.276	0.276	0.248	0.252	0.248	0.235	0.235	0.231	0.258	0.258	0.257
40-7	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.211	0.200	0.200	0.200	0.222	0.250	0.250	0.250	0.250	0.254	0.292	0.288	0.288	0.288	0.288	0.288	0.276	0.276	0.248	0.252	0.248	0.235	0.235	0.231	0.258	0.258	0.257
40-8	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.211	0.200	0.200	0.200	0.222	0.250	0.250	0.250	0.250	0.254	0.292	0.288	0.288	0.288	0.288	0.288	0.276	0.276	0.248	0.252	0.248	0.235	0.235	0.231	0.258	0.258	0.257
41-1	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.180	0.169	0.169	0.169	0.234	0.251	0.251	0.251	0.251	0.255	0.287	0.283	0.283	0.283	0.283	0.283	0.280	0.280	0.247	0.259	0.247	0.230	0.230	0.226	0.222	0.222	0.222
42-1	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.207	0.204	0.204	0.204	0.225	0.250	0.250	0.250	0.250	0.254	0.292	0.288	0.288	0.288	0.288	0.288	0.280	0.280	0.248	0.252	0.248	0.231	0.231	0.227	0.258	0.258	0.257
42-2	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.207	0.204	0.204	0.204	0.225	0.250	0.250	0.250	0.250	0.254	0.292	0.288	0.288	0.288	0.288	0.288	0.280	0.280	0.248	0.252	0.248	0.231	0.231	0.227	0.258	0.258	0.257

Table 1. Continued.

	18-4	18-5	19-1	19-2	19-3	19-4	19-5	19-6	19-7	20-1	20-2	20-3	20-4	20-5	20-6	20-7	20-8	21-1	21-2	22-1	23-1	23-2	24-1	24-2	24-3	25-1	25-2	25-3	26-1	26-2	26-3	25-4	25-5	25-6
34-2	0.241	0.241	0.222	0.225	0.225	0.225	0.225	0.225	0.225	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.212	0.261	0.261	0.211	0.201	0.201	0.271	0.276	0.271	0.247	0.247	0.247	0.250	0.250	0.250	0.247	0.247	0.247
35-2	0.243	0.243	0.228	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.220	0.250	0.250	0.229	0.255	0.255	0.280	0.284	0.280	0.232	0.232	0.232	0.256	0.256	0.256	0.232	0.232	0.232
35-3	0.243	0.243	0.232	0.228	0.228	0.228	0.228	0.228	0.228	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.221	0.246	0.246	0.233	0.251	0.251	0.280	0.284	0.280	0.236	0.236	0.236	0.259	0.259	0.259	0.236	0.236	0.236
34-3	0.233	0.233	0.214	0.218	0.218	0.218	0.218	0.218	0.218	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.204	0.257	0.257	0.204	0.193	0.193	0.259	0.263	0.259	0.247	0.247	0.247	0.246	0.246	0.246	0.247	0.247	0.247
34-4	0.237	0.237	0.218	0.222	0.222	0.222	0.222	0.222	0.222	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.200	0.274	0.274	0.219	0.212	0.212	0.250	0.254	0.250	0.263	0.263	0.263	0.250	0.250	0.250	0.263	0.263	0.263
36-1	0.249	0.249	0.241	0.237	0.237	0.237	0.237	0.237	0.237	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.252	0.252	0.223	0.238	0.238	0.283	0.288	0.283	0.270	0.270	0.270	0.252	0.252	0.252	0.270	0.270	0.270
36-2	0.252	0.252	0.236	0.232	0.232	0.232	0.232	0.232	0.232	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.248	0.248	0.223	0.241	0.241	0.288	0.292	0.288	0.265	0.265	0.265	0.245	0.245	0.245	0.265	0.265	0.265
34-5	0.241	0.241	0.222	0.225	0.225	0.225	0.225	0.225	0.225	0.204	0.204	0.204	0.204	0.204	0.204	0.204	0.208	0.261	0.261	0.211	0.197	0.197	0.254	0.259	0.254	0.255	0.255	0.255	0.254	0.254	0.254	0.255	0.255	0.255
34-6	0.233	0.233	0.218	0.222	0.222	0.222	0.222	0.222	0.222	0.204	0.204	0.204	0.204	0.204	0.204	0.204	0.208	0.261	0.261	0.204	0.197	0.197	0.263	0.267	0.263	0.251	0.251	0.251	0.246	0.246	0.246	0.251	0.251	0.251
34-7	0.241	0.241	0.222	0.225	0.225	0.225	0.225	0.225	0.225	0.204	0.204	0.204	0.204	0.204	0.204	0.204	0.208	0.261	0.261	0.211	0.197	0.197	0.254	0.259	0.254	0.255	0.255	0.255	0.254	0.254	0.254	0.255	0.255	0.255
34-8	0.233	0.233	0.218	0.222	0.222	0.222	0.222	0.222	0.222	0.204	0.204	0.204	0.204	0.204	0.204	0.204	0.208	0.261	0.261	0.204	0.197	0.197	0.263	0.267	0.263	0.251	0.251	0.251	0.246	0.246	0.246	0.251	0.251	0.251
34-9	0.229	0.229	0.210	0.214	0.214	0.214	0.214	0.214	0.214	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.200	0.253	0.253	0.204	0.197	0.197	0.250	0.254	0.250	0.247	0.247	0.247	0.238	0.238	0.238	0.247	0.247	0.247
34-10	0.241	0.241	0.222	0.225	0.225	0.225	0.225	0.225	0.225	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.212	0.261	0.261	0.211	0.201	0.201	0.271	0.276	0.271	0.247	0.247	0.247	0.250	0.250	0.250	0.247	0.247	0.247
34-11	0.237	0.237	0.210	0.214	0.214	0.214	0.214	0.214	0.214	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.212	0.261	0.261	0.207	0.201	0.201	0.259	0.263	0.259	0.247	0.247	0.247	0.254	0.254	0.254	0.247	0.247	0.247
34-12	0.237	0.237	0.222	0.225	0.225	0.225	0.225	0.225	0.225	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.212	0.257	0.257	0.200	0.201	0.201	0.267	0.271	0.267	0.255	0.255	0.255	0.250	0.250	0.250	0.255	0.255	0.255
37-1	0.235	0.235	0.252	0.256	0.256	0.256	0.256	0.256	0.256	0.248	0.248	0.248	0.248	0.248	0.248	0.248	0.248	0.294	0.294	0.245	0.247	0.247	0.305	0.305	0.305	0.274	0.274	0.274	0.300	0.300	0.300	0.274	0.274	0.274
37-2	0.239	0.239	0.230	0.234	0.234	0.234	0.234	0.234	0.234	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.268	0.268	0.196	0.225	0.225	0.271	0.271	0.271	0.251	0.251	0.251	0.258	0.258	0.258	0.251	0.251	0.251
38-1	0.216	0.216	0.242	0.238	0.238	0.238	0.238	0.238	0.238	0.248	0.248	0.248	0.248	0.248	0.248	0.248	0.248	0.248	0.248	0.225	0.245	0.245	0.247	0.251	0.247	0.264	0.264	0.264	0.267	0.267	0.267	0.264	0.264	0.264
39-1	0.222	0.222	0.207	0.210	0.210	0.210	0.210	0.210	0.210	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.210	0.253	0.253	0.219	0.207	0.207	0.241	0.245	0.241	0.221	0.221	0.221	0.245	0.245	0.245	0.221	0.221	0.221
40-1	0.258	0.258	0.219	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.225	0.261	0.261	0.243	0.235	0.235	0.220	0.216	0.220	0.221	0.221	0.221	0.240	0.240	0.240	0.221	0.221	0.221
40-2	0.258	0.258	0.219	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.225	0.261	0.261	0.243	0.235	0.235	0.220	0.216	0.220	0.221	0.221	0.221	0.240	0.240	0.240	0.221	0.221	0.221
40-3	0.258	0.258	0.219	0.222	0.222	0.222	0.222	0.222	0.222	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.222	0.261	0.261	0.247	0.239	0.239	0.220	0.216	0.220	0.221	0.221	0.221	0.240	0.240	0.240	0.221	0.221	0.221
40-4	0.258	0.258	0.219	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.225	0.261	0.261	0.243	0.235	0.235	0.220	0.216	0.220	0.221	0.221	0.221	0.240	0.240	0.240	0.221	0.221	0.221
40-5	0.258	0.258	0.219	0.222	0.222	0.222	0.222	0.222	0.222	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.222	0.261	0.261	0.247	0.239	0.239	0.220	0.216	0.220	0.221	0.221	0.221	0.240	0.240	0.240	0.221	0.221	0.221
40-6	0.258	0.258	0.219	0.222	0.222	0.222	0.222	0.222	0.222	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.222	0.261	0.261	0.247	0.239	0.239	0.220	0.216	0.220	0.221	0.221	0.221	0.240	0.240	0.240	0.221	0.221	0.221
40-7	0.258	0.258	0.219	0.222	0.222	0.222	0.222	0.222	0.222	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.222	0.261	0.261	0.247	0.239	0.239	0.220	0.216	0.220	0.221	0.221	0.221	0.240	0.240	0.240	0.221	0.221	0.221
40-8	0.258	0.258	0.219	0.222	0.222	0.222	0.222	0.222	0.222	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.222	0.261	0.261	0.247	0.239	0.239	0.220	0.216	0.220	0.221	0.221	0.221	0.240	0.240	0.240	0.221	0.221	0.221
41-1	0.222	0.222	0.229	0.233	0.233	0.233	0.233	0.233	0.233	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.243	0.272	0.272	0.232	0.229	0.229	0.231	0.235	0.231	0.239	0.239	0.239	0.262	0.262	0.262	0.239	0.239	0.239
42-1	0.258	0.258	0.219	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.225	0.261	0.261	0.243	0.235	0.235	0.220	0.216	0.220	0.221	0.221	0.221	0.240	0.240	0.240	0.221	0.221	0.221
42-2	0.258	0.258	0.219	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.225	0.261	0.261	0.243	0.235	0.235	0.220	0.216	0.220	0.221	0.221	0.221	0.240	0.240	0.240	0.221	0.221	0.221

Table 1. Continued.

	27-1	27-2	27-3	27-4	27-5	27-6	28-1	28-2	28-3	28-4	28-5	28-6	28-7	28-8	28-9	28-10	28-11	28-12	28-13	28-14	28-15	28-16	28-17	28-18	28-19	28-20	28-21	28-22	28-23	29-1	29-2	29-3	30-1	30-2
34-2	0.249	0.237	0.249	0.245	0.245	0.249	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.238	0.234	0.238	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.226	0.226	0.226	0.255	0.255
35-2	0.251	0.240	0.251	0.247	0.247	0.244	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.299	0.294	0.299	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.239	0.239	0.239	0.243	0.243
35-3	0.251	0.239	0.251	0.247	0.247	0.243	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.295	0.290	0.295	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.243	0.243	0.243	0.246	0.246
34-3	0.253	0.241	0.253	0.249	0.249	0.253	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.234	0.230	0.234	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.243	0.243
34-4	0.262	0.249	0.262	0.249	0.249	0.262	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.234	0.230	0.234	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.234	0.234	0.234	0.243	0.243
36-1	0.320	0.303	0.320	0.312	0.312	0.312	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.269	0.265	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.250	0.250	0.250	0.285	0.285
36-2	0.315	0.298	0.315	0.307	0.307	0.307	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.261	0.257	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.246	0.246	0.246	0.281	0.281
34-5	0.262	0.249	0.262	0.257	0.257	0.262	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.230	0.226	0.230	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.238	0.238	0.238	0.251	0.251
34-6	0.257	0.245	0.257	0.253	0.253	0.257	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.238	0.234	0.238	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.230	0.230	0.230	0.247	0.247
34-7	0.262	0.249	0.262	0.257	0.257	0.262	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.230	0.226	0.230	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.238	0.238	0.238	0.251	0.251
34-8	0.257	0.245	0.257	0.253	0.253	0.257	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.238	0.234	0.238	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.230	0.230	0.230	0.247	0.247
34-9	0.249	0.237	0.249	0.245	0.245	0.249	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.230	0.226	0.230	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.235	0.235
34-10	0.249	0.237	0.249	0.245	0.245	0.249	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.238	0.234	0.238	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.226	0.226	0.226	0.255	0.255
34-11	0.257	0.245	0.257	0.253	0.253	0.257	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.234	0.230	0.234	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.238	0.238	0.238	0.243	0.243
34-12	0.253	0.249	0.253	0.249	0.249	0.253	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.234	0.230	0.234	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.234	0.234	0.234	0.243	0.243
37-1	0.247	0.251	0.247	0.251	0.251	0.251	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.313	0.308	0.313	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.252	0.252	0.252	0.288	0.288
37-2	0.268	0.265	0.268	0.265	0.265	0.265	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.309	0.305	0.309	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.257	0.257	0.257	0.280	0.280
38-1	0.288	0.284	0.292	0.284	0.284	0.280	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.323	0.318	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.225	0.225	0.225	0.284	0.284
39-1	0.267	0.259	0.267	0.267	0.267	0.259	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.289	0.284	0.289	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.240	0.240	0.240	0.260	0.260
40-1	0.240	0.236	0.240	0.244	0.244	0.244	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.241	0.245	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.223	0.223	0.223	0.223	0.223
40-2	0.240	0.236	0.240	0.244	0.244	0.244	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.241	0.245	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.223	0.223	0.223	0.223	0.223
40-3	0.240	0.236	0.240	0.244	0.244	0.244	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.249	0.245	0.249	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.220	0.220	0.220	0.219	0.219
40-4	0.240	0.236	0.240	0.244	0.244	0.244	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.241	0.245	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.223	0.223	0.223	0.223	0.223
40-5	0.240	0.236	0.240	0.244	0.244	0.244	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.249	0.245	0.249	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.220	0.220	0.220	0.219	0.219
40-6	0.240	0.236	0.240	0.244	0.244	0.244	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.249	0.245	0.249	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.220	0.220	0.220	0.219	0.219
40-7	0.240	0.236	0.240	0.244	0.244	0.244	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.249	0.245	0.249	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.220	0.220	0.220	0.219	0.219
40-8	0.240	0.236	0.240	0.244	0.244	0.244	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.249	0.245	0.249	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.220	0.220	0.220	0.219	0.219
41-1	0.248	0.233	0.248	0.241	0.241	0.241	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.261	0.257	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.211	0.211	0.211	0.267	0.267
42-1	0.240	0.236	0.240	0.244	0.244	0.244	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.241	0.245	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.223	0.223	0.223	0.223	0.223
42-2	0.240	0.236	0.240	0.244	0.244	0.244	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.245	0.241	0.245	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.223	0.223	0.223	0.223	0.223

Table 1. Continued.

	30-3	30-4	31-1	31-2	31-3	32-1	32-2	33-1	33-2	33-3	33-4	33-5	33-6	33-7	33-8	33-9	33-10	33-11	33-12	33-13	33-14	33-15	33-16	33-17	33-18	33-19	33-20	33-21	33-22	33-23	33-24	33-25	34-1	35-1
34-2	0.255	0.255	0.257	0.257	0.261	0.209	0.209	0.230	0.207	0.235	0.230	0.211	0.226	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.223	0.223	0.207	0.204	0.211	0.211	0.215	0.230	0.230	0.230	0.230	0.222	0.017	0.175
35-2	0.243	0.243	0.280	0.280	0.284	0.233	0.237	0.214	0.222	0.245	0.244	0.225	0.244	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.244	0.244	0.222	0.222	0.218	0.225	0.225	0.214	0.214	0.214	0.214	0.222	0.186	0.000
35-3	0.246	0.246	0.284	0.284	0.288	0.229	0.237	0.218	0.225	0.248	0.248	0.229	0.248	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.225	0.225	0.221	0.229	0.229	0.218	0.218	0.218	0.218	0.225	0.182	0.003
34-3	0.243	0.243	0.253	0.253	0.257	0.202	0.202	0.226	0.204	0.231	0.226	0.207	0.222	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.212	0.212	0.204	0.200	0.207	0.207	0.211	0.226	0.226	0.226	0.226	0.226	0.008	0.178
34-4	0.243	0.243	0.257	0.249	0.253	0.217	0.209	0.234	0.211	0.239	0.234	0.215	0.230	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.219	0.219	0.211	0.207	0.215	0.215	0.219	0.234	0.226	0.234	0.234	0.226	0.017	0.189
36-1	0.285	0.285	0.255	0.255	0.259	0.251	0.247	0.244	0.241	0.272	0.280	0.245	0.276	0.276	0.276	0.276	0.276	0.276	0.276	0.276	0.248	0.248	0.241	0.237	0.245	0.249	0.241	0.244	0.252	0.244	0.244	0.252	0.213	0.257
36-2	0.281	0.281	0.250	0.250	0.254	0.247	0.243	0.240	0.240	0.276	0.276	0.244	0.279	0.279	0.279	0.279	0.279	0.279	0.279	0.279	0.244	0.244	0.240	0.236	0.244	0.248	0.240	0.240	0.248	0.240	0.240	0.252	0.213	0.260
34-5	0.251	0.251	0.253	0.253	0.257	0.213	0.205	0.226	0.204	0.231	0.226	0.207	0.222	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.212	0.212	0.204	0.200	0.207	0.207	0.211	0.226	0.218	0.226	0.226	0.218	0.011	0.186
34-6	0.247	0.247	0.253	0.253	0.257	0.205	0.205	0.230	0.207	0.235	0.230	0.211	0.226	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.215	0.215	0.207	0.204	0.211	0.211	0.215	0.230	0.230	0.230	0.230	0.230	0.011	0.182
34-7	0.251	0.251	0.253	0.253	0.257	0.213	0.205	0.226	0.204	0.231	0.226	0.207	0.222	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.212	0.212	0.204	0.200	0.207	0.207	0.211	0.226	0.218	0.226	0.226	0.218	0.011	0.186
34-8	0.247	0.247	0.253	0.253	0.257	0.205	0.205	0.230	0.207	0.235	0.230	0.211	0.226	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.215	0.215	0.207	0.204	0.211	0.211	0.215	0.230	0.230	0.230	0.230	0.230	0.011	0.182
34-9	0.235	0.235	0.245	0.245	0.249	0.198	0.198	0.230	0.207	0.235	0.230	0.204	0.226	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.215	0.215	0.207	0.204	0.211	0.211	0.215	0.230	0.230	0.230	0.230	0.230	0.014	0.182
34-10	0.255	0.255	0.257	0.257	0.261	0.209	0.209	0.230	0.207	0.235	0.230	0.211	0.226	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.223	0.223	0.207	0.204	0.211	0.211	0.215	0.230	0.230	0.230	0.230	0.222	0.017	0.175
34-11	0.243	0.243	0.261	0.261	0.265	0.205	0.205	0.226	0.204	0.231	0.226	0.207	0.222	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.208	0.208	0.204	0.200	0.207	0.207	0.211	0.226	0.226	0.226	0.226	0.226	0.008	0.178
34-12	0.243	0.243	0.249	0.249	0.253	0.202	0.202	0.226	0.204	0.231	0.226	0.207	0.222	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.212	0.212	0.204	0.200	0.207	0.207	0.211	0.226	0.226	0.226	0.226	0.226	0.014	0.186
37-1	0.288	0.288	0.245	0.245	0.249	0.238	0.234	0.287	0.279	0.235	0.255	0.275	0.247	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.247	0.247	0.275	0.271	0.279	0.271	0.275	0.287	0.287	0.287	0.287	0.287	0.260	0.255
37-2	0.280	0.280	0.265	0.265	0.269	0.232	0.236	0.251	0.264	0.263	0.263	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.263	0.263	0.259	0.259	0.255	0.259	0.259	0.251	0.259	0.251	0.251	0.267	0.229	0.221
38-1	0.284	0.284	0.245	0.253	0.249	0.251	0.251	0.263	0.276	0.279	0.271	0.272	0.279	0.279	0.279	0.279	0.279	0.279	0.279	0.279	0.279	0.279	0.272	0.272	0.276	0.272	0.272	0.263	0.263	0.263	0.263	0.271	0.245	0.256
39-1	0.260	0.260	0.273	0.281	0.277	0.210	0.213	0.232	0.232	0.239	0.243	0.232	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.239	0.239	0.228	0.224	0.232	0.232	0.228	0.232	0.239	0.232	0.232	0.243	0.218	0.232
40-1	0.223	0.223	0.235	0.235	0.239	0.223	0.219	0.228	0.229	0.209	0.208	0.225	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.228	0.228	0.229	0.225	0.233	0.225	0.229	0.228	0.228	0.228	0.228	0.220	0.196	0.229
40-2	0.223	0.223	0.235	0.235	0.239	0.223	0.219	0.228	0.229	0.209	0.208	0.225	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.228	0.228	0.229	0.225	0.233	0.225	0.229	0.228	0.228	0.228	0.228	0.220	0.196	0.229
40-3	0.219	0.219	0.235	0.235	0.239	0.219	0.223	0.224	0.225	0.213	0.208	0.221	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.232	0.232	0.225	0.221	0.229	0.221	0.225	0.224	0.224	0.224	0.224	0.216	0.200	0.225
40-4	0.223	0.223	0.235	0.235	0.239	0.223	0.219	0.228	0.229	0.209	0.208	0.225	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.228	0.228	0.229	0.225	0.233	0.225	0.229	0.228	0.228	0.228	0.228	0.220	0.196	0.229
40-5	0.219	0.219	0.235	0.235	0.239	0.219	0.223	0.224	0.225	0.213	0.208	0.221	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.232	0.232	0.225	0.221	0.229	0.221	0.225	0.224	0.224	0.224	0.224	0.216	0.200	0.225
40-6	0.219	0.219	0.235	0.235	0.239	0.219	0.223	0.224	0.225	0.213	0.208	0.221	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.232	0.232	0.225	0.221	0.229	0.221	0.225	0.224	0.224	0.224	0.224	0.216	0.200	0.225
40-7	0.219	0.219	0.235	0.235	0.239	0.219	0.223	0.224	0.225	0.213	0.208	0.221	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.232	0.232	0.225	0.221	0.229	0.221	0.225	0.224	0.224	0.224	0.224	0.216	0.200	0.225
40-8	0.219	0.219	0.235	0.235	0.239	0.219	0.223	0.224	0.225	0.213	0.208	0.221	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.232	0.232	0.225	0.221	0.229	0.221	0.225	0.224	0.224	0.224	0.224	0.216	0.200	0.225
41-1	0.267	0.267	0.260	0.260	0.265	0.230	0.222	0.224	0.228	0.232	0.236	0.228	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.228	0.228	0.232	0.232	0.236	0.224	0.232	0.224	0.224	0.240	0.196	0.224
42-1	0.223	0.223	0.235	0.235	0.239	0.223	0.219	0.228	0.229	0.209	0.208	0.225	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.228	0.228	0.229	0.225	0.233	0.225	0.229	0.228	0.228	0.228	0.228	0.220	0.196	0.229
42-2	0.223	0.223	0.235	0.235	0.239	0.223	0.219	0.228	0.229	0.209	0.208	0.225	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.228	0.228	0.229	0.225	0.233	0.225	0.229	0.228	0.228	0.228	0.228	0.220	0.196	0.229

Table 1. Continued.

	34-2	35-2	35-3	34-3	34-4	36-1	36-2	34-5	34-6	34-7	34-8	34-9	34-10	34-11	34-12	37-1	37-2	38-1	39-1	40-1	40-2	40-3	40-4	40-5	40-6	40-7	40-8	41-1	42-1	42-2
34-2																														
35-2	0.175																													
35-3	0.172	0.003																												
34-3	0.008	0.178	0.175																											
34-4	0.022	0.189	0.190	0.014																										
36-1	0.213	0.257	0.256	0.206	0.217																									
36-2	0.213	0.260	0.260	0.206	0.217	0.005																								
34-5	0.017	0.186	0.186	0.008	0.011	0.213	0.213																							
34-6	0.011	0.182	0.179	0.003	0.017	0.206	0.206	0.011																						
34-7	0.017	0.186	0.186	0.008	0.011	0.213	0.213	0.000	0.011																					
34-8	0.011	0.182	0.179	0.003	0.017	0.206	0.206	0.011	0.000	0.011																				
34-9	0.014	0.182	0.179	0.005	0.014	0.213	0.213	0.014	0.008	0.014	0.008																			
34-10	0.000	0.175	0.172	0.008	0.022	0.213	0.213	0.017	0.011	0.017	0.011	0.014																		
34-11	0.014	0.178	0.175	0.005	0.019	0.202	0.202	0.014	0.008	0.014	0.008	0.011	0.014																	
34-12	0.014	0.186	0.182	0.005	0.019	0.210	0.210	0.014	0.003	0.014	0.003	0.011	0.014	0.011																
37-1	0.248	0.255	0.259	0.252	0.260	0.326	0.330	0.252	0.252	0.252	0.252	0.256	0.248	0.256	0.248															
37-2	0.229	0.221	0.225	0.221	0.229	0.229	0.232	0.229	0.221	0.229	0.221	0.225	0.229	0.221	0.217	0.207														
38-1	0.249	0.256	0.260	0.245	0.237	0.222	0.218	0.245	0.245	0.245	0.245	0.241	0.249	0.249	0.241	0.248	0.220													
39-1	0.221	0.232	0.232	0.210	0.210	0.210	0.207	0.218	0.214	0.218	0.214	0.210	0.221	0.210	0.218	0.251	0.214	0.226												
40-1	0.200	0.229	0.233	0.196	0.204	0.252	0.252	0.204	0.200	0.204	0.200	0.189	0.200	0.196	0.204	0.250	0.246	0.265	0.220											
40-2	0.200	0.229	0.233	0.196	0.204	0.252	0.252	0.204	0.200	0.204	0.200	0.189	0.200	0.196	0.204	0.250	0.246	0.265	0.220	0.000										
40-3	0.204	0.225	0.229	0.200	0.208	0.256	0.256	0.208	0.204	0.208	0.204	0.193	0.204	0.200	0.208	0.254	0.242	0.265	0.216	0.003	0.003									
40-4	0.200	0.229	0.233	0.196	0.204	0.252	0.252	0.204	0.200	0.204	0.200	0.189	0.200	0.196	0.204	0.250	0.246	0.265	0.220	0.000	0.000	0.003								
40-5	0.204	0.225	0.229	0.200	0.208	0.256	0.256	0.208	0.204	0.208	0.204	0.193	0.204	0.200	0.208	0.254	0.242	0.265	0.216	0.003	0.003	0.000	0.003							
40-6	0.204	0.225	0.229	0.200	0.208	0.256	0.256	0.208	0.204	0.208	0.204	0.193	0.204	0.200	0.208	0.254	0.242	0.265	0.216	0.003	0.003	0.000	0.003	0.000						
40-7	0.204	0.225	0.229	0.200	0.208	0.256	0.256	0.208	0.204	0.208	0.204	0.193	0.204	0.200	0.208	0.254	0.242	0.265	0.216	0.003	0.003	0.000	0.003	0.000	0.000					
40-8	0.204	0.225	0.229	0.200	0.208	0.256	0.256	0.208	0.204	0.208	0.204	0.193	0.204	0.200	0.208	0.254	0.242	0.265	0.216	0.003	0.003	0.000	0.003	0.000	0.000	0.000				
41-1	0.185	0.224	0.224	0.189	0.196	0.230	0.233	0.185	0.193	0.185	0.193	0.193	0.185	0.193	0.196	0.225	0.229	0.265	0.210	0.226	0.226	0.230	0.226	0.230	0.230	0.230	0.230			
42-1	0.200	0.229	0.233	0.196	0.204	0.252	0.252	0.204	0.200	0.204	0.200	0.189	0.200	0.196	0.204	0.250	0.246	0.265	0.220	0.000	0.000	0.003	0.000	0.003	0.003	0.003	0.003	0.226		
42-2	0.200	0.229	0.233	0.196	0.204	0.252	0.252	0.204	0.200	0.204	0.200	0.189	0.200	0.196	0.204	0.250	0.246	0.265	0.220	0.000	0.000	0.003	0.000	0.003	0.003	0.003	0.003	0.226	0.000	

Appendix 2. Partial sequences of Mitochondrial cytochrome c oxidase subunit I (COI) obtained and applied in this study. (184 individuals of 22 species from Northeast Asian waters and 11 individuals of 4 species from other regions for comparison).

Alitta cf. *brandti*

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Cheilonereis shishidoi

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Composetia sp. nov.

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Nereis heterocirrata

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Nereis aff. *pelagica*

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Nereis sp. nov. 3

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Nereis multignatha

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Perinereis shikueii

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Perinereis singaporiensis

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Perinereis vallata

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Perinereis wilsoni complex

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CAGACCGAAATTTAAACACAGCCTTTTTTGACCCGGCGGGGGGAGGAGACCCTATTTTATACCAGCACTTATT
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